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HOLIDAY ACCIDENTS.

We have not read of many Christmas-tree fires since that holiday. This may be an accident, as it is possible there has been the usual number, but they have not been brought to our notice. We are, nevertheless, willing to attribute some of this decrease to the increasing use of miniature incandescent lamps in place of the old, dangerous candle. In the past two or three years this form of decoration has been becoming more and more popular. The cost is not great, and the effect is more beautiful than that obtainable with the candle.

The Christmas holiday is preceded, or followed—whichever way one counts—by another dangerous day—the Fourth of July. It would seem at first that electricity has nothing to offer to decrease the danger of celebrating this last-named holiday, but this is not so, for a well-known professor of physics has invented an electric acetylene cannon, which is absolutely safe, introduces practically no fire risk, can make as much noise as any boy can wish for, and can be fired as fast as his heart desires. Let us hope for a wider use of this or some other safe method of making a noise, so that the heart-rending accidents reported in the summer may become as few as those due to the winter celebration.

THE ANNUAL REVIEW.

Following our usual custom, we present in this issue a review of the electrical industries during the year just closed. This review is noteworthy, not only for its completeness, taking up, as it does, all branches of electrical activity, but for the names of our contributors. Each of these special articles has been prepared by a gentleman standing high in that branch of the art, and who has had exceptional advantages for preparing a review. The articles themselves are of unusual interest. They are not mere statistical summaries, but deal with each subject so as to bring out the important developments and indicate the possible trend of future work.

Electrical methods have spread so rapidly, not only in lines of work where they have been introduced for years past, but in so many new lines that this new agent is rapidly becoming one of the most important factors of our commercial world. A review of the electrical industries is, to a large extent, a review of the world's industrial progress; it is more than a mere record of electrical buyings and sellings, for there is a deeper significance.

The new year has opened most auspiciously. The outlook is for unparalleled prosperity in all branches of electrical application. With this growth the ELECTRICAL REVIEW will keep step. The high standard set will be maintained. The paper will not be devoted to any one branch of the electrical profession, but will serve the interests of all.

The pages of the ELECTRICAL REVIEW record, week by week, the progress in electrical science and technics and contain all electrical news. This information is not buried under a mass of uninteresting material, but is presented in an attractive manner. It is readable and accurate.

ELECTROLYTIC METERS.

Not long after electric lighting was introduced and when the electric motor was just making an entrance into the power field, the need was felt for some means of measuring the amount of power used by each consumer. It is satisfactory at first to charge a fixed rate for each unit, whether it be a lamp or a motor, and to let the consumer use it as much or as little as he pleases, but when the field has been more thoroughly developed and more users have been secured, the burden put upon the central station by the unnecessary use of current, as well as the demand of consumers that they should be allowed to pay for what they use and no more, make it essential that some means of measuring the use made of current in each case should be

devised. The earliest method, we believe, was the electrolytic meter employed by the Edison company. The company maintained, as well as it was able, a constant voltage, and the meter measured the ampere-hours delivered to each establishment, so that a satisfactory basis for charging was obtained, provided, of course, reliance could be placed upon the performance of this meter. Unfortunately, the electrolytic meter, as employed, was not satisfactory; it was subject to many errors and was altogether an undesirable and unmechanical device. The invention of the motor-meter entirely displaced it.

The electrolytic meter has, however, one or two features worth considering: it is a simple device, inexpensive to make, and is without mechanical parts. If we can overcome its disadvantages it might become a useful instrument.

Two recent attempts in this direction were described in a paper presented some time since before the Institution of Electrical Engineers, of Great Britain, by Mr. S. H. Holden, an abstract of which appears on another page of this issue. In both of these meters a radical change has been made from the earlier type of electrolytic meter in obtaining a record. In the former instrument metal was dissolved from one electrode and deposited upon the other, and one or the other weighed. This was not a convenient arrangement—indeed, it was not accurate. It was suggested that if the electrolyte could be decomposed instead of the electrodes that a more convenient device might be obtained; but the objection to this scheme is the difficulty of determining the amount of decomposition which has taken place by measuring the gases evolved.

This difficulty, it is said, has been overcome in the two instruments. One, attributed to Bunsen, does not measure the gases evolved, but weighs the electrolyte, the loss in weight being a measure of the ampere-hours. The other is still more ingenious. In this the amount of decomposition is determined by the amount of gas evolved, but by supplying a certain amount of this gas at the anode the volume of the electrolyte is kept constant. This feature removes many of the objections to depending upon the volume of gas as a measure of electrolytic decomposition. At the same time it provides a more or less permanent instrument—one which does not require refilling every month. From the records which Mr. Holden gave this instrument appears to give fairly satisfactory results. As compared with the motor-meter, however, it would seem that its great virtue lies in its simplicity and hence cheapness. And it gives another interesting instance of the reappearance of an old device some fifteen years after it had been discarded.

THE REAPPEARANCE OF THE AUXILIARY POLE.

Early in the development of the dynamo, when commutating troubles were beginning to be serious, due to the increasing size and voltage of the machines, means were sought for bringing this troublesome feature under control. One of these means was the placing of an auxiliary pole at or near the commutating plane of the armature so as to provide a magnetic field for reversing the current in each armature coil as it passed through this position and thus do away with the disastrous sparking which followed from the imperfect action of the normal type. This design never came into great use, for it was found that by modifying the designs, both of the field and of the armature, a commutating field could be provided which was satisfactory for all conditions under which the generator would be called upon to operate. Indeed, this factor was brought so thoroughly under control that it was demanded of all machines that there should be no necessity for shifting the brushes, even under the severest conditions of operation. The same skill in design enabled manufacturers to turn out a traction motor which would operate in either direction and on all loads without any shifting of the carbon brush. It should be added that the carbon brush has been an important aid in bringing commutation under control.

To-day it is somewhat surprising to notice the reappearance of this auxiliary pole in several lines of work some fifteen years or so after it had been entirely discarded. The severer conditions under which commutation must be made in dynamos driven by steam turbines has made it seem advisable to some designers to return to this old principle. The comparatively high speeds at which these large direct-current generators must run makes particularly difficult the design of the commutator, makes a carbon less desirable than at lower speeds and hence an auxiliary commutating field is added to overcome the new troubles.

In another field of application the auxiliary pole has also been put to good use. This is to enable that ideal method of varying the speed of a shunt motor by varying the excitation of the fields to be used, without making the motor too large or introducing disastrous sparking. Where a commutating field of sufficient intensity to prevent sparking can be maintained independently of the strength of the main field, the latter may be varied through a wide range without affecting commutation.

In still another type of machine we find the auxiliary pole reappearing. The well-developed types of traction motor, so satisfactory in smaller sizes, become less so in larger sizes, thus increasing the difficulty of constructing large electric locomotives. An attempt to overcome one of these troubles was shown recently in London, where a 200-horse-power traction motor was exhibited which was fitted with auxiliary poles. This device was used here to enable the motor to carry a much greater overload than would be permissible with a stationary motor, this being possible because of the improved ventilation due to its peculiar situation.

It is always interesting to notice the reappearance of an old, discarded device. A poor feature of a machine in its early stage of development is frequently corrected by an auxiliary appliance, which later becomes unnecessary when the theory of the machine is better understood and the device is therefore dropped. Later on, when severer conditions are imposed, the method of treatment so satisfactory for ordinary conditions will not answer and we find the old device taken up again and made an important feature of the new design. History in the electrical arts not infrequently repeats itself in this way.

CAN THE ATOMS OF ORDINARY MATTER BE BROKEN UP?

The exceedingly interesting and valuable researches in radioactivity have brought out many new ideas. In this study the work of Rutherford has been particularly striking, not only because of the fact that he has identified the different stages of what is believed to be atomic disintegration, but for the very suggestion itself of the possibility of a change in the atom. This breaking up of the atom, complicated as it seems to be, appears to be entirely beyond the influence of any conditions we are able to bring to bear. The radiations and emanations are given off at a definite rate, no matter how the radioactive substance may be treated.

On the other hand, when a radiation such as the Rœntgen rays is allowed to fall upon a substance, the latter becomes itself a secondary source of rays which may be more complicated than the exciting radiation. This has been a puzzling phenomenon, and to explain it two suggestions have been made, due, we believe, to J. J. Thomson. It may be that the primary rays actually tear apart the atoms of the substance upon which they fall, thus making the latter, in a sense, radioactive; or it is possible that the secondary rays are due merely to the freeing of corpuscles or other subatomic particles attached to, but not forming part of, the molecules of the matter themselves. An interesting and suggestive investigation has been made by Dr. H. A. Bumstead to see whether he could obtain any evidence pointing to the one or the other explanation as being the more probable. His method of attacking the problem is based upon the assumption that if the atoms of the material are really torn apart by the primary radiation that the effect would be different for different materials, and since the greater part of the energy thus set free would probably appear as heat, it should be found, upon investigation, that the amount of heat radiated by different materials exposed to the same conditions would be different.

Acting upon this assumption, Dr. Bumstead decided not to attempt to make a direct measurement of the energy liberated, but to make a comparison of the secondary radiations given off by two metals when exposed together to the same Rœntgen ray. For this comparison a convenient instrument is furnished by the radiometer, a modified type of which he constructed. This instrument, and the results accomplished by means of it, Dr. Bumstead describes in the issue of the *American Journal of Science* for January. The work was not at all easy and a number of troublesome features were encountered which had to be overcome. Of course, from such a preliminary investigation no definite conclusions could be drawn; in fact, a wide research, using a great many materials subjected to a large number of conditions, should be made before any deductions can be made with confidence, but the work showed that when lead and zinc are exposed to the same radiation, under the conditions which he employed, that much more heat appears to be developed in the lead than in the zinc. This observation would be in accordance with the first explanation of the complexity of secondary radiations. Should the results be verified by further research, this is an important discovery. It has been suggested that if we accept the theory that radioactive elements are undergoing a process of disintegration, there is no reason why we should stop here, and we might as well assume at once that all matter may be going through a similar process, though the changes are so exceedingly slow that we have no means of detecting them. Under normal conditions most atoms are stable, but the severe shaking up caused by exposing them to Rœntgen rays is more than they can stand, and some of the least stable are torn to pieces. A further investigation in this direction would be of much interest. If we can tear apart atoms of some of the elements, some different material must remain, and what are the residues obtained from the different elements? But before one plunges over his head in speculation, he should have more evidence, though the opening is enticing.

THE ELECTRICAL AGENT.

At this time of the year, when it is proper to review the gain made in all branches of electrical activity, one is more impressed than ever by the manifold uses now made of this agent. We are so accustomed to our trolley roads, to the telephone, to the electric light and all other applications of electricity that we now accept them as matters of course, and only on the occasion of some new and unexpected application are we aroused to further admiration at the wonderful flexibility of the new power. However, when reviewing the progress of a year's work, when one must take up, one after the other, the various electrical arts and record the growth of each, as well as its introduction into new fields, one can not but be impressed by the variety of uses to which electricity is put. What other agent have we which does the heavy work as well as the most delicate? Can any other be used both for transmitting the human voice and for hauling heavy trains; for calling a boy from the next office; or delivering a message to an unseen vessel; for illuminating our largest buildings or for lighting up our innermost recesses, so that the surgeon can see what is out of gear? What other source of power can be turned to on a hot summer day to cool off the tired citizens of a sun-baked town, and possibly in the same city is employed for producing the highest temperatures known to man? Does my lady realize, as she boils her breakfast egg on a little electric stove, that she is using the agent which is employed for reducing the most refractory minerals and producing by the ton metals which a year or two ago were exhibited as curiosities? Truly this form of power is the most flexible and the most convenient which we have yet brought under control.

It is, however, in this feature of electricity that its whole value lies: we never produce it for itself alone. It is only useful as a means of getting something else. It is the voice we wish to hear through the telephone and not to feel the current; it is the light given out by the electric lamp; the mechanical power developed by the electric motor and the heat of the electric arc that are useful; it is the refined metal we are after in our electrolytic processes. Electricity is simply the agent—the man of all work—which can be turned to do one thing or another, as the need may be, and, the prejudiced electrician will add, it does all of them well.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XVI.

Wide Distribution of Radioactive Matter and the Origin of Radium.

The most strongly radioactive substances—radium, actinium, polonium—apparently occur in very small quantities. Even the more feebly radioactive elements thorium and uranium, are not among the more common chemical elements.

A question of very great importance in connection with the study of radioactivity is this; is radioactive matter small in quantity and confined to a few sets of conditions, or is it widely distributed? The fact that it exists in any one locality, or with any one association, only in small quantity, does not throw any light on the question of the scope of its distribution.

Before taking up the theories of radioactivity, we shall review briefly our knowledge of the distribution of radioactive matter, as far as our globe is concerned.

RADIOACTIVE MATTER IN THE EARTH.

It has been shown by Elster and Geitel that air confined in spaces in contact with the earth, such as certain caves, becomes radioactive. This was shown to be due to the presence of radium in the ground, which diffused into the air, since air confined by itself in a metal vessel away from contact with the soil, did not become radioactive.

The same result was obtained, and to a more marked extent by taking air from some depth below the surface of the soil by means of a pump. Such air contained sufficient of the radium emanation to induce radioactivity upon the walls of the containing vessel. The radioactivity decayed at such a rate as to leave no question that it was produced by the radium emanation.

Similar results have been obtained by others, so that there is now no reasonable doubt that the radioactivity of air in confined spaces is due to the presence of radium emanation, which gradually diffuses from the ground.

It was shown by Ebert that air which is radioactive, loses its radioactivity when passed through a tube surrounded by liquid air. It will be remembered that Rutherford, by this means, condensed the emanation from radium and obtained it in the liquid condition. This is another bit of evidence that goes to show that the radioactivity of the air in contact with the earth is due to the radium emanation.

The amount of radioactive matter in the soil seems to vary greatly from place to place. Clay soil seems to be the most radioactive, but sandy soils are not infrequently radioactive.

A piece of non-radioactive clay was buried at some depth in the earth, and was found after a time to become radioactive. This was an induced radioactivity, due to the deposition upon it of radium emanation. When air is sucked through clay, it was shown by Elster and Geitel that it manifested considerable radioactivity.

Carbon dioxide that came from great depths in the earth, was found to be radioactive. It lost its radioactivity on standing for some days.

A quite appreciable quantity of radioactive matter has been found in certain waters that percolate through the soil, and especially in those that come from considerable depths. J. J. Thomson has shown that the tap-water of Cambridge, England contains radioactive matter, while the waters from certain deep wells were found to contain quite appreciable quantities of the highly radioactive emanation. This emanation decayed at such a rate, as compared with the emanation from radium, as to show that the two were identical.

Similar results were obtained by Bumstead and Wheeler from the waters at New Haven, Connecticut.

One of the most interesting results in this connection has been found in connection with certain hot springs, such as at Bath, in England. The water of this spring, which comes from great depths, is slightly radioactive, but the mud deposited from the water is strongly radioactive, due to the presence of the radium emanation.

It is also a matter of importance that in the gases that escape from this spring, *helium has been found.* This helium comes, almost beyond question, from the decomposing radium emanation, and shows that radium exists at great depths beneath the surface of the earth.

The simultaneous occurrence of these two elements, and the fact that helium is produced from the radium emanation, leads us to suspect the presence of radium wherever helium is found—as in the sun.

RADIOACTIVE MATTER IN THE AIR.

It has long been known that a charged body surrounded by air loses its charge more rapidly than can be accounted for by the leak through the supports. This would show that the air is ionized to some extent.

The cause of this ionization remained for a long time unknown, and, indeed, has only recently been discovered. After the discovery of radium and its comparatively wide distribution, it occurred to Elster and Geitel that radium might be present in small quantity in the air, and if so, this would account for the ionization and conductivity of the air. They undertook to test the atmospheric air for the presence of radioactive matter, and in the following manner.

It had already been shown by Rutherford that a negatively charged wire, suspended in the presence of the emanation from radium or thorium, would collect upon it the radioactive decomposition products of the emanation. Elster and Geitel, utilizing this fact, exposed a long wire charged to a high negative potential to the air, and then tested it for the presence of radioactive matter.

After the wire had been thus exposed for several hours, it was placed in a closed vessel with a charged electroscope. The latter was discharged much more rapidly than normally, showing the presence of radioactive matter upon the wire, which ionized the gas around the electroscope.

The presence of radioactive matter upon the wire was further shown by rubbing the wire with a piece of leather that had been dipped in ammonia. The leather became quite strongly radioactive. When a negatively charged wire was suspended in air which had remained undisturbed for a long time in contact with the earth, as in certain cases, Elster and Geitel showed that enough radioactive matter was deposited upon the wire which when removed by a piece of leather produced a visible fluorescence in barium platinocyanide when brought near to the leather.

The same experimenters studied the rate at which the radioactive matter upon the negatively charged wire underwent decay. It was found to decay like the radioactive matter deposited from the radium emanation.

If the wire was charged positively no radioactive matter was deposited upon it. Since the radioactive matter was drawn to and deposited upon a negatively charged wire, and not upon a positive wire, we must conclude that the radioactive matter in the air is charged positively.

All of these facts point to one conclusion. The radioactive matter in the air comes from the radium emanation. This shows that *radium emanation is present in the atmosphere.*

The amount of radium emanation in

the air varies greatly in different localities. In certain cases the radioactivity of the air is relatively great, as has already been stated. The amount of radium emanation in the air in some localities is more than a dozen times as great as in other regions. Certain experiments made in northern Norway would seem to show an abnormally great amount of radium emanation in the air in that region.

Since the radium emanation in the air probably comes from radium in the soil, the amount of the emanation in the air in any section of country may be taken as a rough index of the amount of radium in the soil in that region. This is, of course, only an approximate relation, unless frequently repeated tests were made, since the winds shift the air so frequently from one region to another.

Elster and Geitel found that the radioactivity of the air not only changed from one locality to another, but was *not constant in any given locality.* It varied with a number of conditions. The *lower the barometer* the greater the induced radioactivity in the air in any given region. This is just what would be expected if the radioactive matter in the air came from radium in the earth. The radium emanation being a gas, diffuses from the earth in which it is formed, from the radium present there, into the atmosphere. The lower the barometric pressure the more emanation will pass out of the fissures and fine pores in the earth into the atmosphere. Since the radioactive matter in the air comes from the radium emanation, the lower the barometer the more radioactive matter present in the air.

Elster and Geitel also showed that a negatively charged wire collects more radioactive matter from the atmosphere when the wind is blowing than when the air is still. This is in perfect accordance with the views already advanced. When the air is in motion more radioactive matter comes in contact with the wire than when the air is at rest, and, consequently, more is collected upon it. Eve showed that a wire charged to 10,000 volts collects radioactive matter at a distance of forty to eighty centimetres. All these facts point to the same conclusion, which is that already stated, that the air contains a form of radioactive matter. This conclusion is still further confirmed by the following facts.

FRESHLY FALLEN RAIN OR SNOW RADIOACTIVE.

If the air contains radioactive matter we might expect that some of it would be carried along with objects moving mechanically through it.

Fortunately the means for testing this conclusion are supplied to us by nature. When drops of rain or flakes of snow fall through the atmosphere they might be expected to carry down with them some of the radioactive matter in the air. This has been tested by C. T. R. Wilson in England, and in the case of snow by Allan in Canada. Wilson found that freshly fallen rain showed the presence of quite an appreciable amount of radioactive matter. This radioactivity, however, rapidly decayed.

If barium chloride is added to freshly fallen rain, and the barium precipitated by sulphuric acid, the barium sulphate that is thrown down is quite radioactive, showing that the radioactive matter in the water is carried down with the precipitate.

Both Wilson and Allan found that newly fallen snow was radioactive. When a considerable quantity of the snow was melted and the resulting water evaporated, a radioactive residue was left behind.

The radioactivity, however, rapidly decayed, as in the case with the freshly fallen rain. All of the above facts taken together leave no reasonable doubt as to the presence of radioactive matter in the air.

IS MATTER IN GENERAL RADIOACTIVE?

Having found a number of chemical elements that are radioactive, and having shown that these are radioactive to such different degrees, the question naturally arises, are there not other substances that possess radioactivity? It is possible that there may be a large number of the chemical elements that are feebly radioactive, or all matter might be radioactive to some slight extent.

The first experiments bearing upon the broad question were those of Mme. Curie, and these gave negative results. She examined a large number of the chemical elements for radioactivity, and found it manifested only by those already considered. The question in this connection is whether the method employed by Mme. Curie was sufficiently sensitive.

An exactly opposite result has since been obtained by a number of investigators, and especially by Strutt. Strutt, Cook and others have undoubtedly proved that ordinary matter, in general, is radioactive to a very slight extent, but unquestionably radioactive.

Having settled this point, it still remains to determine whether this slight radioactivity is due to the substances themselves, or to radioactive matter deposited in minute quantities upon them. There is, as yet, not sufficient experimental data to decide this point.

THE ORIGIN OF RADIUM.

We have seen that radium is unstable, undergoing continual decomposition. From the rate at which radium is decomposing, it has been pointed out by Rutherford that if the whole earth was pure radium, 16,000 years hence it would have only the radioactivity of good pitchblende.

Since many of the minerals that contain radium have existed much longer than the above period, it is obvious that radium must be produced from something, or all of the radium would long since have disappeared. The interesting and important problem is, then, to find out what is the source of radium; from what substance or substances is it produced?

Since radium occurs in uranium minerals, it was early suspected by Rutherford that radium might be produced from uranium.

Soddy, working with Rutherford, took up this problem and published his results in 1904. A kilogram of uranium nitrate was freed from radium until it contained less than 10^{-12} grams, which was the smallest quantity that could be detected by the electroscope. The uranium nitrate was then allowed to stand for twelve months, and was tested again for radium. Soddy points out that the presence of radium in the laboratory renders the electroscopes incapable of detecting such minute traces of radium as they otherwise could do. He, however, feels justified in stating that the amount of radium in the kilogram of uranium nitrate, after it had stood for a year, was less than 10^{-11} grams. Soddy concludes that this settles the question as far as the production of radium from uranium is concerned. Uranium can not be regarded as the parent of radium, since, from the above result, if any radium is produced from uranium, less than one ten-thousandth of the theoretical quantity necessary to maintain the present condition of equilibrium is produced.

Soddy adds, however, that "The result of course may be explained by assuming the existence of intermediate forms between uranium and radium." He, however, thinks that such assumptions are not justified.

Just a week prior to the publication by Soddy in *Nature,* a short article appeared in the same journal by Whetham, in which he stated that he had examined several specimens of uranium compounds, which had been preserved in the laboratory from

seventeen to twenty-five years. A larger amount of radium emanation was obtained from these old specimens than from more recently prepared samples of these same uranium compounds.

This observation was, to say the least, suggestive, and made it highly desirable that more work should be done along this same line.

Phases of Electrical Developments During 1905.

THE most striking feature of the past year in the electrical industries is the commercial development in practically all lines. This indicates a most satisfactory condition. It is proof that the arts have reached a stage where they are recognized as desirable investments and as invaluable aids in other branches of industry. It indicates that electrical methods are turned to more and more by other industries and by the commercial world in general. The great convenience of the telephone, the advantages of electric traction, the satisfaction produced by electric lights are well established, but they are being recognized more and more by the public at large. This has been the feature of the year and it is found to be true of nearly all branches of electrical activity.

The railway world in general is interested in electric traction to-day as it never has been before. It has seen this method of transportation drive out all other methods for tramway systems and obtain a good start in heavier work. It is this reaching out into a wider territory that has brought about the present acute controversy between the advocates of the direct-current and alternating-current systems. A noteworthy incident of the year was the decision of the New York, New Haven & Hartford Railroad to adopt the alternating system and to use this side by side with the direct-current system as employed by the New York Central & Hudson River Railroad. To offset this growing interest in the alternating system it was proposed during the last month of the year to raise the voltage used in direct-current systems some two or three times, and thus obtain some of the economies enjoyed by the alternating system. But whichever system may be the favored one in the end, the trend of the year has shown that the steam roads are looking more and more into the virtues of the electric motor.

The feature in the transmission field has been the increasing confidence shown by financiers in these undertakings. No unusual work has been done, but the fact that capital is not now so hard to interest shows that a great gain has been made during the year. It should be mentioned that during the past year several of the large hydroelectric units in the new stations at Niagara Falls have been put into service, and that for some time past power has been transmitted for about 300 miles in California.

The development in the telephone field during the past year has been unprecedented. It has been much greater than one dared forecast from the most favorable reports of the previous year. As an indication of what this growth has been, it may be said that in New York city alone there has been an increase of about 75,000 instruments. The telephone is now recognized as an essential part of the furnishing of every hotel and of the better equipped apartment houses. It is now thought necessary that a building of this kind should be fitted with a private exchange and an instrument placed in each suite. This development in New York is typical of that in all large cities. At the same time the attention of the companies has been directed energetically toward developing the rural districts.

The electrical supply companies have paid more attention than ever to the sale of current. They have sought by advertisements in the daily papers and by solicitation to introduce the electric light where it has not been used before, to encourage the employment of the electric motor in place of all other motors and to sell current for other purposes. Particular attention has been paid to the development of heating and cooking by electricity. In fact to-day it may be said that an electrical supply is as essential for a city as is either gas or water.

In telegraphy the companies have the ground pretty well covered and have turned their attention to increasing the effectiveness of their systems. The most noteworthy event as regards the Postal Telegraph-Cable Company has been the introduction of the Jones "Phantoplex" system, which makes it possible to send an additional message over a wire already in use either for simple Morse or quadruplex systems. The Western Union Telegraph Company has made most satisfactory progress with the Barclay printing telegraph system, which it has employed during the past year on some of its most important lines.

In wireless telegraphy nothing of special significance has occurred. The developers of the various systems have devoted a great deal of attention to perfecting their apparatus. A number of times during the year this system of communication was put to excellent use, saving lives and property which, without it, would undoubtedly have been lost.

The increasing use of all electrical systems has, of course, been felt by the manufacturers of electrical apparatus and these have had a prosperous year.

No startling discoveries have been made in electrical science. Study in the interesting and important field of radioactivity has been pushed, possibly to the neglect of other lines of research. But the phenomena of this former branch promise to add so greatly to our fundamental conception of physical laws and matter itself that this activity is, on the whole, desirable. The theories and explanations which now slip so easily from the tongues of those responsible for the great advance in this work are not accepted without question in all quarters, showing a healthy opposition which will aid greatly in steadying the work of the former investigations.

As a whole the development has been most satisfactory. The engineer and the inventor have done their work in providing systems that were needed. During the first stages in the development of a new industry a considerable effort is necessary to persuade the public of its usefulness. Later on, when its value is recognized, conditions are reversed. Where, before, persuasion was needed, now there is a demand. This stage has been reached in the electrical industries, for the year 1905 was marked by the increase in the demand for, and the use of, electrical apparatus. It is not inferred that all electrical problems have been solved—far from it; for we are to-day face to face with a number of particularly difficult ones. But we can claim the credit for having supplied mankind with a number of things which he is glad to have and for which he is undoubtedly better off.

Power Transmission in 1906.

By Dr. F. A. C. Perrine.

AT THE opening on another new year, as we looked backward and forward at the science, art and industry of power transmission, we find for the new year less problems awaiting solution than ever before and remark about us a more general sentiment of contentment with the progress made and a greater confidence in the results accomplished than at any previous period.

A striking proof of this is to be found in the high regard now felt by the great financiers for water-power securities. This change in sentiment began about a year ago when there was floated on the New York and Boston markets securities of several water-power companies which previously had sought in vain for patronage and since that time the education our bankers then received has been apparent in the eagerness with which they have sought such opportunities and the intelligence with which they have made their investigations in separating the good from the bad, choosing such as by their success will give a future stability to investment in such securities.

Heretofore the developments made were only such as small local men could carry with much pains at peril of failure from the smallness of their capital, though it must be noticed that the very small number of failures reflect much credit upon the ability and grit of these same small men.

The continual rise in the price of coal and the almost continuous disturbances in the coal fields have undoubtedly contributed much toward this change in sentiment and these same causes will probably in the future call to the attention of these same financiers the fact, which is not yet clearly recognized, that by the means of electrical generation and transmission is the only present method by which the small independent coal miner can market his product. A small operator can not afford to build his own railroad and the large operator, who is also a railroad owner, will not allow the small operator the same market advantages as he himself enjoys, no matter what legislatures, courts or railroad commissions may say, but it is open to the little fellow to build his own power plant and distribute his coal electrically without fear of destructive competition, for such competition would affect more markets than one and would result in a wholesale reduction in prices which the large operator would not care to contemplate.

In the science of power transmission the most serious problem yet awaiting complete solution is that of the lightning arrester. Much progress has been made during the past year and some of the work already done promises for the next year developments which will put us along very far toward the solution of this very troublesome problem. At least one new solution along radically new lines is being offered which promises important improvement.

The troublesome insulator problem seems to have been largely solved and there are now in successful operation at least six plants successfully operating at between 50,000 and 70,000 volts and reliably energizing over 1,500 miles of line. During most of the past year one company has been regularly supplying current at a distance from the power-house of about 300 miles.

In the art of power transmission we find the tower-pole line with spans of about 500 feet practically standardized. None of the anticipated troubles with this type of construction has been seriously encountered, till it has become a recognized fact that such lines are more easily erected and more easily operated in daily service, while such lines lend themselves easily to means for continuous lightning protection.

The synchronous motor equipped with an automatic regulating device has aided much in the control of the terminal voltage. While such means of voltage regulation naturally makes possible satisfactory operation at a greater line loss, still the practice remains of keeping down the line loss and impedance and it is properly felt that a mistake would be made in returning to the line loss of from fifteen to twenty-five per cent for which lines of eight years ago were calculated, even though a satisfactory control of the terminal voltage might be accomplished.

While we can by modern methods make the bad good, there is no need in erecting obstacles to perfect service simply because we have learned practically how to overcome them.

In the industry of power transmission I have already noted the most important advance in the change of sentiment of capital toward such investments. This has made possible a more regular dependence upon the water-power developments, to the extent of the building of mills, lighting plants and railroads in the neighborhood of water powers, even where they are not yet developed. Provision is more commonly made for the easy introduction of such power, whenever it may be offered, and in some cases sites have been chosen for factories in anticipation of such development.

One startling transmission of about 700 miles is promised for the undertakings of the coming year, but I anticipate more of a steady growth and many battles of great companies for territory and the full development of the rivers by the means of gas and steam auxiliaries than I do of any other elements of advance.

Great things are always doing and attracting our attention, but the greatest of all is when an art and an industry has reached a settled basis from which it may make great strides in development and become of general use.

The Railway in 1905.

By Dr. Louis Bell.

DURING the year just concluded there has been about the usual degree of activity in building new roads, but nothing especially novel has presented itself in their equipment save that a small group of single-phase roads, projected some time since, have been put in operation with, upon the whole, good results. Information regarding their performance is rather scarce, for as yet they are being put out in rather tentative fashion, but no reports of serious failure have leaked out, and since there are plenty of Job's comforters quite ready to speed bad tidings the absence of their dismal reports indicates that things are going pretty well. Of this single-phase matter more will be said later. From an opera-

tive standpoint things have been going about as usual. One regrets having again to call attention to the frequency of accidents on the larger urban and interurban roads, but if anything the situation in 1905 was worse than that in 1904. The terrible accident on the New York system is still fresh in every one's mind, and even the Boston elevated, which has heretofore had a remarkable record for safe operation, fell victim to a series of collisions and derailments that fortunately were without fatal results. Most of the accidents were on the fast interurban lines, and one is tempted to ask with some acerbity why people will insist on operating electric lines with a disregard of safety precautions that would have been discreditable to a steam road of thirty years ago.

The fast interurban car of to-day can not be stopped in any short space even by the best air-brakes available, and for safety must be operated with some regard to proper headway, and the same sort of precaution that has been found necessary on steam roads. No adequate excuse for collisions can be offered by either. A car can not fairly be considered as under control unless so operated as to be capable of stopping before it gets dangerously near another, and if the road has blind corners so much the worse for the road and so much more care is necessary to keep the cars under control.

In physical equipment there have been few changes. On the larger work now being undertaken there is a wholesome tendency to use steel cars similar to those on the New York subway. The lesson of the Paris catastrophe has not been wasted and the fireproof car is a long step in advance, especially for operation on elevated and underground lines. Electric roads have displayed commendable energy in adopting the steel cars, in which they might with advantage be imitated by railroads in general. It is a pity that similar energy is not displayed in the matter of fenders, which lags as it has done for years past. That the fender problem is a difficult one every one who has investigated the subject knows only too well. However, in the present state of affairs there is no reason for retaining types of fender that by reason of too great clearance practically increase the danger instead of diminishing it. A really good fender would considerably shorten the annual casualty list.

An interesting tendency in equipment is the somewhat increasing use of trailers, traceable probably to the increasing use of multiple-unit control, which makes the public familiar with the use of short trains. The trailer certainly gives a very easy method of increasing the capacity during rush hours, and with modern motor equipment it can be very easily operated. The sole question seems to be that of safety. Merely to hitch a motorless car behind a motor-car does not constitute a proper trailer equipment, and in the writer's opinion the best results would be reached with a somewhat highly specialized trail-car planned for that service and no other. With proper precautions there seems to be no reason why trailers can not be used with entire safety and with considerable gain in emergency capacity.

In generating stations and equipment there has been no unusual development. The steam turbine seems to be in increasing favor, and there is an interesting prospect of more use of direct-current turbo-generators, the coming of which will be a great boon to the smaller plants that so often suffer acutely from bad load-factors. The 2,000-kilowatt direct-current turbo-generator being installed in the Dorchester substation of the Boston elevated system will prove a valuable demonstration, especially as it is in a plant which has shown exceptional economy with its existing equipment. The load-factor in this station is, however, both high and steady, so that whatever the turbine may do there it should be able to excel relatively in plants where engines work under less favorable conditions. It may be noted, too, that the same company has contracted for two producer-gas-engine plants for substation working, one of 975-kilowatt, the other of 700-kilowatt capacity. Taking this in connection with the installation of the first 4,000-kilowatt gas-engine set in San Francisco, and one is forced to admit that competition in prime movers is getting acute. By the end of the current year some definite data from these gas plants should be available. If they make anything like the showing guaranteed they will be the forerunners of many others. In particular they will lessen the need for elaborate transmission schemes, especially in parts of the country where natural gas is available. Power transmission from central stations for railway working has of late sometimes been pushed to a point where it shows small economy, and probably sometimes waste, which condition can be materially improved if gas-engine sets of moderate capacity prove a success. An interesting feature of some recent railway installations has been the use of portable substations mounted on cars and available for cutting into service either to help out a damaged station or to furnish added capacity at points of heavy load. A 1,000-kilowatt rotary thus capable of service at any point needed is a powerful reenforcement. The Long Island Railroad, which has gone in during the year for electric traction upon a large scale, has two such portable stations, which are used to good advantage.

But by far the most important issue of the year has been the advance toward alternating-current traction on a large scale, including the placing of a large order for alternating-current locomotives by the New York, New Haven & Hartford Railroad and the recent publication of correspondence between Mr. Westinghouse and the New York Central Railroad regarding the advantages of such apparatus. As every one will remember, at the time this latter road decided upon electric traction, the single-phase alternating-current motor was suggested and to a certain extent discussed, but, as Mr. Westinghouse himself admits, the situation at the time was such as to make the choice of continuous-current apparatus desirable. At the present time he maintains that conditions have so changed as to make a change to alternating current highly advantageous.

It is clear enough that alternating-current traction has made material progress in work, however, of much less magnitude than that here concerned. The advantage of alternating-current motors from the standpoint of distribution is very great. On present standard practice a long electric road has to be operated at about 600 volts on the working conductors, and is fed from substations at substantially the same distances apart that would be chosen if they were independent generating stations. The physical equipment is then substantially the same as if no power transmission at high voltage were undertaken save that the substations are saved the operation of steam plants. In addition there is the central station with its raising transformers, high-tension lines and reducing transformers at the substations. In case of alternating-current operation there would be no substations requiring special attendants, no rotary converters, and instead of a distribution at 600 volts, *via* the third rail required for transmitting energy for heavy trains at so low a voltage, there would be a distribution *via* an overhead conductor at say 3,000 volts. The saving in first cost is evidently very great, and the gain in safety and freedom from leakage and short-circuits secured by the abolition of the third rail is highly im-

portant. From every point of view save that of the exploiter of direct-current machinery the alternating-current distribution is desirable. The sole question which can fairly be raised is the sufficiency of the single-phase series motors in undertaking railway work upon a large scale. And upon this point it must be admitted that the evidence is far from conclusive at the present moment. The type has the failing common to all true single-phase motors of receiving an intermittent energy supply, which implies motors which, other things being equal, are somewhat heavier and rather less efficient than the direct-current motors for the same service. This failing is inherent and unavoidable, however it may appear to be circumvented by exceptional skill in design. And, besides, there is considerable doubt concerning the successful commutation of alternating current upon a large scale. The difficulties of commutation increase with the output in the case of alternating-current motors much as they do in the case of high-voltage machines for direct current. The commutation in a 6,000-volt arc dynamo for six or seven amperes may be perfectly good from a practical standpoint, although a generator of the same voltage for sixty or seventy amperes might, and from all experience on the subject certainly would, give very serious trouble. It is this quantitative phase of the matter which makes it so difficult to judge fairly of the probable situation as regards large alternating-current locomotives. So long as they are in the experimental stage in the hands of the makers one can form no very accurate idea of their probable performance, and lacking this, one has to suspend judgment, however unwillingly. If they are an unqualified success from the operative point of view, a very long step forward in electric traction will have been taken.

Meanwhile Mr. Sprague, than whom no one has a better right to speak with authority on electric traction, maintains that the resources of direct current are far from exhausted and that operation at 1,000 to 1,500 volts, and perhaps more, on the working conductor is perfectly feasible. If he can make good this position the advantage of alternating-current working will to this extent be diminished, but at the cost of breaking away from the standard direct-current lines quite as completely as by taking up with alternating-current methods.

There are minor difficulties to be overcome in alternating-current traction, but there are also minor gains, as in regulation and comparative immunity from electrolysis, so that the main question is, in effect—will the New York, New Haven & Hartford alternating-current locomotive prove a success in the sense in which one can use that word of large direct-current locomotives? 1905 has neither furnished the answer nor sufficient data for computing it. Perhaps 1906 may be more fortunate. Meanwhile the raising of this plain issue is by all odds the most significant event of the past year in electric railroading. The use of high voltage on the working conductors is the one thing needful for large railway work, whether it comes by one method or another.

Electrical Science in 1905.

By Dr. John Trowbridge.

THE year 1905 has not been marked by any epoch-making discovery in electricity and magnetism. Great interest, however, has been excited by the account of the magnetic alloys described by Heusler. These alloys consist of manganese, aluminum and copper, which, under suitable conditions of temperature, show a magnetic state comparable with that of cast iron. From a theoretical point of view this discovery is very significant, and may lead to a modification of the molecular theory of magnetism. In some remote period, when the supply of iron ceases, this discovery, now insignificant, may have a commercial value.

The theory of the electron and the negative corpuscle continues to supply the mathematical physicists with a subject for profound analysis.

The most notable papers on this subject are those of H. A. Lorentz, of Amsterdam, who discusses the theory from his own standpoint and that of Drude. In this theory we seem to be getting a plausible point of view of the mechanism of electric conduction.

The theory of the negative corpuscle or that of the electron assumes a peculiar interest at this moment to Americans, for it seems to revive the Franklin theory of one fluid, inasmuch as it makes a positive body negative by a detachment of the negative particle, thus causing a deficit. One can find many analogies between Franklin's theory and the new theory, analogies which would please the heart of that venerable philosopher were he now alive. Most physicists, however, regard the new theory, together with that of ions and carriers of electricity, as a convenient scaffolding, which is likely to be pulled down as the edifice of our electrical knowledge grows.

The subject of wireless telegraphy has exercised the minds not only of inventors but also of those engaged in scientific investigation. An interesting paper on this subject has been published in the *Annalen der Physik*, No. 12, 1905, by J. S. Sach, who shows that the earth connection in many cases is prejudicial and that it can be superseded to great advantage by wires parallel to the earth and insulated from it. Sach also shows how the apparatus should be arranged with respect to the direction of transmission, discusses the influence of trees, buildings and persons standing near the sending and receiving ends. He states that he could get no messages inside the laboratory near his field of observation. His results can be readily explained by his employment of short waves. The best and most extended work in the subject of wireless telegraphy has been done by Dr. G. W. Pierce, of the Jefferson Physical Laboratory, who, in an extended series of papers published in the *Physical Review* and in the proceedings of the American Academy of Arts and Sciences, has discussed the best conditions for sending and receiving the greatest amount of electrical energy. Pierce has shown, independently, that the earth connection can be superseded to advantage by wires parallel to the earth and insulated from it; and by the use of long waves he has had no difficulty in receiving messages inside the Jefferson Physical Laboratory. The inventor would do well to study Dr. Pierce's results.

The use by Marconi of Rutherford's magnetic detector lends considerable interest to a paper by E. Madelung, *Annalen der Physik*, No. 10, 1905, on the magnetizing by rapidly oscillating currents, such as are used in wireless telegraphy. He finds that with the use of the discharges from Leyden jars which are oscillatory that the hysteresis curves undergo a remarkable modification, peculiar bulges or loops being formed outside the usual area formed by magnetizing with steady rise and fall of currents. He terms the hysteresis

curves and their modification produced by the oscillatory currents the dynamic curves, and those of the usual kind the static curves. The modifications he attributes in large measure to eddy currents.

At the beginning of the new year one naturally reviews one's own labors. I have been engaged in studying with high electromotive forces and powerful steady currents the effect of the magnetic field on the production of X-rays and have obtained the interesting result that if the anode is made the pole of a powerful magnet, bulbs exhausted to a very high degree, which only give hard rays, can be made to give soft rays; thus the magnetic field serves as a magnetic regulator, allowing great penetration or strong contrasts. It seems likely that this magnetic regulator will be of service in hospital practice.

Commercial and Engineering Tendencies Affecting Central Stations.

By J. H. Hallberg.

ONE can not fail to be impressed with the consolidations of electric light, power, railway and gas plants, which have been effected during the past few years. The prime motive of consolidation is to reduce the expenses, and to simplify the operation of such properties, thereby increasing their earning capacity, and also the reliability of the service. As a matter of fact many important financial and banking interests are now controlling several large consolidated gas and electric properties, which have, under new management, with the assistance of a capable engineering force, been changed from small non-dividend paying plants into magnificent modern properties capable of earning handsome dividends for the stockholders.

The owners of such modern consolidated plants are, however, not the only ones who are benefited, but the consumers as well as the public, in fact the entire municipality is benefited to probably a greater extent. The first step which is usually taken after consolidating several small plants is to establish a large power station (which may be combined with a gas plant) somewhere where water and fuel are easily available. This means that the plant is located some distance away from the prominent parts of the city, thereby removing from the heart of the city several small plants which are generally objectionable on account of smoke, dirt, noise and the necessity of hauling fuel and ashes over the oftentimes expensively paved streets of the city. The modern station is equipped with tall chimneys, and smoke-consuming devices which entirely overcome the smoke nuisance, and on account of its location other objections are usually done away with. When several small companies are supplying gas and electricity in the same municipality there are, of course, necessary several different sets of gas mains, electric conduits, pole lines, etc., some of which, upon consolidation, become superfluous, and may be removed with great advantage to the property owners and to the public. The removal of duplicate poles and line wires will materially simplify the system and will reduce the liability of accidents from broken wires, and will beautify the streets of the city. When the entire electric light, power, railway and gas equipment is under the control of one management, the placing of new poles, opening of street, etc., can be reduced to a minimum, and can be done with greater expediency than if several different companies are in control, which means absence of cooperation.

The simplifying of the plants and the system and the ability to make extensions and repairs for the mutual benefit of all departments at one time results in uniform construction and maximum economy which could otherwise not be effected. The consumer as well as the public at large is therefore always benefited by such consolidations, and as a most forcible example the electric light and power plants in New York city may be referred to where the public has benefited by the removal of many small plants, unnecessary poles, line wires and other duplications, and where the consumers have had the benefit of a reduction from twenty-five to thirty-three and one-third per cent in the cost of electricity for lighting during the past few years. There is also another point of advantage in favor of consolidation which greatly benefits the municipality, and that is, that its control over the gas and electric supply is more complete, as it holds only one corporation responsible instead of several.

These unprecedented developments call for large and special apparatus which have not been required until recently, and have given to the manufacturers opportunities to exploit and develop new steam and electric apparatus which are conducive to economy, simplicity and reliability of service. It may not be out of place to refer to a few of the more recent developments along these lines which are now taken advantage of by the operators of modern electric properties.

POWER STATION.

The demand for and commercial perfection of large generating units is undoubtedly responsible for the evolution in power-station design and construction. A visit to a modern power station reveals the absence of many small engines, belt and rope-driven generators and manually operated switchboards. A few years ago the separate demands for commercial lighting and power, street lighting and electric railways made it necessary for the central station to generate and distribute several kinds of electric power, which meant considerable duplication of apparatus. The tendency is to generate one kind of power and the polyphase alternating current has been adopted as a standard. The generating of alternating currents for all classes of central station load permits the introduction of large high-speed alternating-current generators, directly connected to steam turbines. Such units are now operating very satisfactorily under commercial conditions, and it appears that the depreciation usually charged against reciprocating engine units can be materially reduced. The economy of the steam turbine is still disputed, but it may be safely accepted as equal to the best reciprocating engines of equal capacity under full load. It is generally understood that the turbine economy exceeds that of the reciprocating engine with less than one-half load. The alternating-current steam turbo sets operate smoothly in parallel with any other generators, and the difficulties of synchronizing and parallel operation of alternators are entirely overcome.

Improvements have also been made in the reciprocating engines which facilitate parallel operation. The magnificent installations of Allis-Chalmers cross-compound combined horizontal and vertical engine units in the Interborough Rapid Transit Company's power-houses in New York city may be referred to as the latest development in reciprocating engine construction.

Where large reciprocating engines are

installed it is possible to place a low-pressure turbo set in the engine exhaust main, thereby materially increasing the efficiency of the plant. As a matter of fact, an 800-kilowatt low-pressure Curtis turbine with Alberger condenser has recently been installed in the exhaust main of a 2,500-horse-power Corliss non-condensing engine in a large power station, effecting a gain of about sixty-six per cent of the output of the original generating unit. If a 2,500-horse-power condenser had been installed, the gain would not have exceeded thirty per cent.

The consolidation of gas and electric properties has also opened up a field for large gas engines to drive electric generators. The author is of the opinion that before long the gas engine unit will prove a formidable competitor of the steam-driven prime movers. It also seems practical to install gas engine units in place of storage batteries to take care of sudden and unexpected loads, and also to help out during the peak of the load. The gas engine is rapidly developing into a commercial and reliable machine, and can be built in all capacities required for central station practice. The first cost of the gas engine installation compares favorably with either steam or storage battery equipment. Where the storage battery is required for emergency purposes only the gas engine unit is preferable and has the great advantage of being able to continuously carry the load if necessary, and is subject to a lesser degree of depreciation.

A gas and electric corporation can establish a gas engine substation operating directly from the gas mains in such districts where the electric light and power have taken the place of gas, thereby avoiding the installation of storage batteries and the heavy peak loads on the central station can be removed and without having to install new feeders or gas mains. The use of gas engine units will show a reduction of from fifteen to twenty-five per cent in the cost of current at the switchboard in a station previously operated by condensing steam engines or turbines.

In the storage battery substation the gas engine unit may effect a saving of fifty per cent or more.

The growing demand for the gas engine, and the fact that the greater part of its development has been accomplished, should soon materially reduce the manufacturing cost, and there seems to be no good reason why a gas engine electric plant should not be installed complete for seventy-five per cent of the present cost of a reciprocating steam engine plant within a few years.

The modern central station switchboard is a wonderful combination of instruments, switches and apparatus. The placing of all high-voltage switches in separate fireproof compartments in some out of the way place, and operating them by small low-voltage control switches from a distance is conducive to great reliability of service and safety to the operators. This method also permits one operator to have charge of a large number of instruments and switches which, operating on low-voltage currents, can be placed very close together, also economizing on space and facilitating rapid control of the generating apparatus and the feeder circuits.

DISTRIBUTION SYSTEM.

The distribution system of a modern central station has been made more efficient and reliable by using better conduit systems, insulators, cables, wires, protecting cutouts and lightning arresters. The construction work is also of a higher class and under the supervision of more experienced men, and all changes are ordered by an engineering department which constantly makes tests on the system and is familiar with the future requirements. The tendency is to generate three-phase current which can be carried to the centres of distribution over three or four wires. From the centres of distribution the current can be distributed single-phase over two wires unless larger than twenty-five-horse-power motors are to be operated, in which case it is recommended that three wires be run for three-phase motors. It has for some time been customary to remove all small transformers and install larger ones of higher efficiency. The Wright maximum demand meter is oftentimes of great help in determining the most economical size of transformer required for any given section.

The manufacturers of service boxes, switches, meters, etc., are constantly improving their products, and it is the tendency of the modern central stations to avail themselves of these improvements at the earliest opportunity.

Much attention has recently been given by the managers of modern stations to proper systems of meter rates, of which there are several to choose from, some being more applicable and satisfactory than others, but in very few instances can any general system of rates be universally adopted without modification to suit local conditions.

STREET LIGHTING.

The series alternating-current arc lamp is still in the front rank for street lighting, although it is soon to be expected that the new magnetite arc light, operating in series on constant-current transformers in connection with rectifiers, will prove a strong competitor, especially on account of the white light emitted and also because of its comparatively high efficiency. The magnetite arc lamp operates about 100 to 150 hours with one trimming, and it is understood that the system operates very satisfactorily for street lighting.

COMMERCIAL LIGHTING.

During the past year a new high efficiency high candle-power incandescent lamp has been placed on the market by the General Electric Company, which furnishes a most valuable addition to the commercial lighting equipment of all central stations. The lamp is at the present time manufactured in three sizes, consuming from 125 to 250 watts, requiring approximately two and one-half watts per candle-power without reflector. Special prismatic reflectors, equipped with strong holders, which can be attached to any ordinary incandescent lamp socket, can, however, be furnished for use with them. One style of reflector diffuses the light over a comparatively large area, and with this reflector the current consumption equals about two watts per candle-power. Another style prismatic reflector is also available, which concentrates the light directly below the lamp, in which case the consumption is slightly over one watt per candle-power, thus favorably competing with the arc lamp. The high-efficiency incandescent lamp can in many instances satisfactorily replace direct-current arc lamps operating with less than four amperes, also alternating-current arc lamps operating below six amperes. The light from the high-efficiency lamp is whiter than that from the ordinary incandescent lamp, and the size of the units available is just right to suit almost any commercial requirement.

Within the past few months there has been introduced a new line of arc lamps using impregnated carbons. These lamps are commonly known as "flame-arcs," and operate two in series on any voltage from 100 to 120 direct current, requiring a minimum of about six amperes and a maximum current of fourteen amperes for each series of two lamps. The light from the flame-arc is very powerful, and by using different kinds of filling for the core in the carbon the color of the light may be changed at will. At the present time the flame-arc lamp is not recommended for indoor use on account of the gases set free while it is burning. For

outdoor illumination, and especially for advertising, this lamp is very satisfactory, and will soon be an important factor in that class of lighting. The only objection to the flame-arc is that it requires trimming every ten to fourteen hours—depending upon the length of the carbons. A large number of these lamps are now operating in New York city in front of theatres, photograph galleries, restaurants and similar places, and they are attracting a great deal of attention, and it is understood that the call for the lamps is greater than the supply.

The demand for electric power for advertising purposes has been greatly increased by persistent solicitation on the part of the operating company, which also in many instances supply electric signs and similar advertising devices free of charge or for a small rental, and in some cases where the customer wishes to purchase his own electric sign he can do so at the company's cost price. When signs are furnished by the company free of charge or on the rental basis, it is the tendency to have the lettering on the sign signify the business of the consumer and not his name, so that if for any reason the sign should have to be cut out it is available, without change, for another consumer.

POWER.

The day load of the modern central station has been increased to a large extent during the past few years, and it is safe to state that in most cases the day load is as great and more profitable than the night load. This great increase in the consumption of current during the day is due to the large number of motors which are now required for all kinds of manufacturing establishments, and the tendency is to make a comparatively low rate for all current taken during the daytime, and if a customer can be had who will require a steady supply of current at all times, excepting during the peaks of the load, he is entitled to a special low price, and many of the large central stations have shut down isolated plants and secured good customers by proper discrimination in rates.

AUXILIARY SERVICE.

There is perhaps no consumer who is more unsatisfactory to the central station than the isolated plant, who contracts for auxiliary or emergency service, and no auxiliary connections should be made to isolated plants unless a contract is made for at least one year, with a fixed charge of not less than ten per cent on the total investment for power plant, feeders, mains and service connections (notwithstanding the fact that the apparatus, cables, etc., may be available without additional investment). The usual cost of a central station and distribution system varies between $200 and $600 per kilowatt, depending upon the construction, therefore ten per cent per year on the lowest cost would represent $20, and ten per cent on the highest cost would be $60 per year per kilowatt of maximum demand, which represents the fixed charge to be paid by an auxiliary consumer before any current is taken, for which a separate charge should be made. The auxiliary service business should be avoided as much as possible, unless some arrangement, as outlined above, can be made, and the tendency of the larger stations is to follow this practice.

All modern central stations are now members of the National Electric Light Association, and they send, at the expense of the company, their managers, superintendents and other representatives to the yearly meetings, where they have an opportunity to listen to valuable papers and enter into discussions which are of immense value to the progress of the central station business. Many managers and employés are also members or associate members of the American Institute of Electrical Engineers, through which they also receive valuable information.

It is the tendency of modern central stations to avail themselves of consultations with experts who have broader opportunities for observing the latest developments than their managers and superintendents, whose time is occupied with the operation of their plants.

The owners of many central stations have found it profitable to have periodic examinations and reports, with suggestions made by competent consulting experts, and no plant can afford to neglect advice or suggestions which will put it on a more economical basis.

A Review of Wireless Telegraphy.

By Wm. Maver, Jr.

COMPARED with the progress of wireless telegraphy during the first ten years of its existence, the rise of electric wire telegraphy was slow. Morse devised his telegraph relay and recording register in 1844, but it was not until a quarter of a century thereafter that any very notable advance in the art was made.

To be sure, the conditions in the early days of wire telegraphy were not so favorable to its rapid growth as were the conditions which existed when electric wave telegraphy, without wires, was brought forth. In 1844 the world at large was more or less sceptical as to the practicability of wire telegraphy and the business communities had to be educated to its advantages. This will be self-evident when it is stated that the revenue derived from the first two telegraph wires between New York and Philadelphia for the half-year ending June, 1846, reached the munificent total of $293.17—less than two dollars a day.

When, on the other hand, the advent of wireless telegraphy was heralded, even in its original more or less imperfect state, it not only arrested the attention of the world by reason of its wonder-inspiring character, but it found a large portion of those that go down to the sea in ships anxiously awaiting its coming. Here was a demand for service which wire telegraphy had never been able to meet—that of furnishing a means of communication between ships at sea and ships and the shore. Wire telegraphy could not supply this demand and neither could any other existing system of signaling do so satisfactorily. For, as Admiral Dewey has recently well said, "The principal use of wireless telegraphy is now and long will be at sea—between ship and ship, or ship and shore. On shore other means of communication always exist, often better, always possible substitutes. The common telegraph or telephone, or the heliograph, permanent or portable, is everywhere available to the soldier or the meteorologist. Permanent outlying stations can be connected by submarine cables. Although wireless telegraphy may be an added convenience, on shore it never can be indispensable. But from ships at sea, out of sight of flags or lights and beyond the sound of guns, the electric wave, projected through space, invisible and inaudible, can alone convey the distant message."

The present successful operation of

long-distance wireless telegraphy has been due to the employment of increasingly sensitive detectors, more powerful transmitters, separate or closed oscillating circuits, and to improved arrangements of the antennæ or vertical wires.

Probably the most important part of a modern wireless telegraph outfit is the detector of the electric waves. These waves, which are of a high order of frequency, have been developed concurrently with every lightning flash since the beginning of the world, but the means necessary to perceive them was lacking until toward the end of the nineteenth century, when Dr. Hertz made his notable demonstration of the existence of electric waves in free space by the aid of his copper ring detector or resonator.

This detector, while not intended originally for the purposes of wireless telegraphy, was in fact the first known wireless telegraph detector, but the distance to which signals can be transmitted by means of this detector is very limited, perhaps not more than two or three yards.

Following the Hertz wave detector came the Branly filings coherer, which was designed originally to show the effect of electric waves upon metal filings. It was Dr. Branly's discovery that when such filings are made a part of an ordinary electric circuit, including a small battery and galvanometer, electric oscillations cause the filings to cohere, thereby increasing the electrical conductivity of the filings very materially; but rather unfortunately the filings retain this conducting quality after the oscillations cease, until they are shaken or jarred, when they resume their normal high resistance. In 1894, at a lecture before the Royal Institution, London, the Branly coherer was employed as a detector of wireless telegraph signals at a distance of 120 feet by Sir Oliver Lodge, who then predicted, but not without misgivings, that it might be possible to receive wireless signals by this instrument at a distance of half a mile. To decohere the filings Lodge used a bell clapper operated by clockwork.

It was, however, little more than a year after the Lodge experiments that Marconi, using the filings coherer and with vertical wires forty feet high, succeeded in transmitting wireless signals to a distance of three or four miles. Subsequent improvements of the filings coherer by Marconi and others speedily produced a much more sensitive detector than the original Branly coherer, and this improved instrument is now giving excellent service in connection with the Morse recording register in providing the means whereby dots and dash signals can be transmitted and translated by a layman after a few days' practice. Indeed, it is with this instrument that much of the wireless telegraph business of the world is to-day being transacted. It is used quite generally by the Slaby-Arco (the Telefunken Wireless Telegraph Company), the Branly-Popp and the Rochefort companies. It is also used extensively in the Marconi wireless equipments and almost exclusively by the navies of the world.

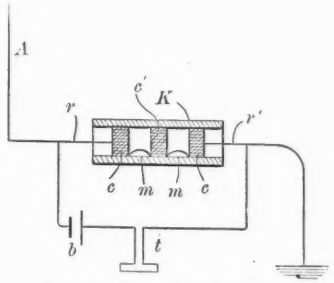


FIG. 1.—CASTELLI COHERER.

Nevertheless, the filings coherer has the disadvantage of being somewhat slow in its action and rather difficult to maintain in proper adjustment. The fact also that this detector does not decohere automatically, but requires a "tapper," is another disadvantage.

It was therefore soon considered desirable that a detector of electric waves which would decohere automatically should be discovered; that is, a detector which would change its normal condition on the occurrence of electric oscillation in its circuit and immediately resume its normal condition upon the cessation of the oscillations. In the very early days of wireless telegraphy the means of procuring a successful detector of this type was not self-evident, but fortunately for the progress

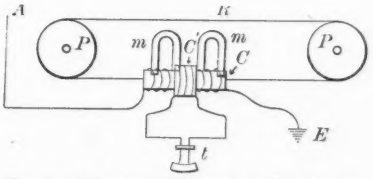


FIG. 2.—MARCONI MAGNETIC DETECTOR.

of the art detectors of this type were not long in forthcoming. In fact some of the prominent workers in this field, like Fessenden, De Forest and, perhaps, Lodge and Muirhead, have from the first employed automatic or self-righting detectors; while Marconi, Slaby-Arco and others now also employ autodetectors.

Among the first autodetectors that were devised, and probably the first practical one, is that known as the Castelli or Italian Navy mercury coherer. This device, which is outlined in Fig. 1, consists of an insulated tube *k*, resembling the tube of the filings coherer, with metal rods *r r'*, leading into the tube. At their inner ends these rods are connected with pieces of carbon *c c*; *c'* is also a piece of carbon. In the spaces between the carbons are inserted small globules of mercury *m m*. The vertical wire or antenna A is connected to rod *r*; *r'* is connected to ground. A small battery *b* and a telephone receiver *t* are in a shunt circuit with the coherer. On the occurrence of electric oscillations in the circuit the mercury and the carbon cohere, whereupon the resistance of the circuit decreases. When the electric oscillations cease, decoherence at once follows and the resistance of the telephone circuit thereupon rises. These variations of resistance vary the strength of current in the circuit, with the result that long and short sounds or tones, corresponding to the signals transmitted, are heard in the telephone. The variations of current thus set up are sometimes of sufficient strength to operate a sensitive Morse relay, whereby a record of the incoming signals may be obtained if desired. This relay may also be employed to ring a "call" bell. This detector has the drawback that it loses its effectiveness after some use, thus necessitating fresh mercury and more or less frequent cleansing of the tube.

Marconi has devised a magnetic autodetector, the operation of which is based upon the fact that electric oscillations hasten the demagnetization of a magnet which is undergoing slow changes of magnetism. This detector is outlined in Fig. 2. It consists of two coils of fine wire C C', one wound over the other. The inner coil C is in the circuit of the vertical wire A; the outer coil C' is made a part of the circuit of a telephone receiver *t*. There is no battery in this circuit. A slender rope of fine iron wires R is caused to pass slowly through the inner coil C by means of the pulleys PP, operated by clockwork. Two permanent magnets *m m*, with their ends resting loosely on the coils, similar poles being in juxtaposition, tend to magnetize inductively the wire rope. As the iron rope moves past these magnets it is continually undergoing magnetic changes, but these changes, and consequently the changes in the magnetic field, occur too slowly to induce perceptible currents in the telephone circuit. When, however, the electric oscillations, due to the transmitted signals, arrive, the changes of magnetism in the core occur abruptly, inducing currents in the coil which are heard as long and short noises in the receiver *t*. Satisfactory results are obtained with this detector, which is employed interchangeably with the filings coherer in many of the Marconi wireless installations. A recent report states that Marconi has devised a magnetic detector which will operate a relay.

This review will be continued in the next issue, dealing with further details of apparatus and systems.

Electrochemistry and Electrometallurgy in 1905.

By Charles F. Burgess.

THE electrodeposition of metals for protection and ornamental purposes constituted the beginning of industrial electrochemistry and electrometallurgy. The electroplater's art, whose growth has been continuous during the last half century, had as its offspring the electrolytic refining of copper, and during its short but successful struggle for existence comparatively little attention was paid to the other possibilities which the electric current offered in producing chemical transformations.

It would have required a prophetic gift of high order twenty-five years ago to assert that in 1905 electrochemistry and electrometallurgy would constitute a well-defined and generally recognized branch of technology, that national societies having the promotion of its interests as their object would be in existence, that six or more technical and scientific journals would devote their columns almost exclusively to marking the progress being made in this field; and that the demand for technical men would be such as to induce our technical schools to establish courses of study in electrochemical engineering. Yet all this has come to pass.

The year 1905 may be claimed to mark the close of the first important decade of industrial electrochemistry in this country. This has been a period of remarkable growth, witnessing the development of the aluminum industry, the extensive production and utilization of calcium carbide, the supplanting by electrochemical methods of the older chemical processes for the manufacture of alkalis, bleach, chlorates, sodium, chlorine, bromine and many other products. Carborundum, siloxicon, artificial corundum and other hard and refractory materials have been added to our list of useful substances. Metallic silicon and calcium have come into existence as industrial elements. Nature's monopolistic control of the supply of graphite has been overthrown through successful methods of transforming coal and other forms of carbon into this valuable material.

Although closing a most remarkable period, the past year has not in itself been prolific in spectacular events and important discoveries. Its comparative uneventfulness does not, however, indicate any decline of interest or endeavor in this field nor is it to be taken as evidence that industrial electrochemistry has approached its ultimate status. On the contrary, the past twelve months have seen a most substantial development. Our knowledge of electrochemical phenomena has been elaborated and through a close study of details improvements in existing processes have been effected.

Certain authorities attribute the successful activity of the past ten years more or less directly to study along theoretical lines, and certain it is that the evolution of theory has been equal in magnitude and simultaneous with that along industrial lines. Without doubt that school of electrochemists that stands sponsor for the electrolytic dissociation and allied theories has dominated the scientific field of electrochemical activity; and though vigorous and growing reaction against such domination has arisen, even the opponents agree that this school has rendered a service of inestimable value in stimulating research, while not admitting the intrinsic value of the theories set forth.

The theoretical electrochemists have ranged themselves into two groups, the exponents and opponents of the theories of the Nernst, Ostwald, Arrhenius school. In the parlance of the great college game there have been few spectacular plays during the past season, the defence of the former has not been particularly strong, and the offence of their opponents has not been as aggressive as in previous years. Each accuses the other of misinterpreting the rules and each is industriously, though quietly, searching for new materials which will bring strength in future contests.

A fact which might be noted as indicative of the growth of electrochemistry, its present importance and the large number of workers in the field, is that the Concilium Bibliographicum has undertaken to publish a card-catalogue of the current literature of electrochemistry and allied subjects, giving a brief review of the important publications of interest to electrochemists. It is estimated that about five thousand such card-reviews will be published per annum.

Few reliable statistics are available from which a numerical estimate may be compiled showing the growth and importance of industrial electrochemistry. This lack of data may be ascribed to various causes. The secrecy with which the electroplaters used to surround their art and which was abandoned by them long ago was inherited by the copper refiners and later passed on by them to the newer electrochemical industries. On account of the strenuous efforts which are made to discourage competition the public is often kept in ignorance, not only of the magnitude of existing industries, but also of the very existence of certain of them as electrochemical ones; especially is this true in organic work. Further, it is being more thoroughly appreciated that electrical energy is a most useful agent in improving certain steps of existing processes, steps which, while important in themselves, are not sufficiently important to allow the term "electrochemical" to be applied in designating the whole operation.

It is customary to estimate the growth of industrial electrochemistry by the developments at Niagara Falls, which as the world's greatest centre of electrochemical activity, has just completed its first decade of existence. Among the more recent developments perhaps the most interesting is the production of silicon, that most abundant of Nature's elements which was unlocked to the industrial world over a year ago, and which is now being made under conditions such that it can be supplied in any quantity required to meet the demands which will be placed upon this element through new uses which are being discovered for it.

Among the new electrochemical products placed upon the market during the past year are an interesting series of compounds manufactured by the Niagara Electrochemical Company. "Oxone" is the trade name given to a fused sodium peroxide, a hard stone-like substance which when immersed in water gives off 315 times its volume of oxygen. It thus becomes possible to generate this gas in the same manner that acetylene is generated from calcium carbide. This new product should prove of great value not only in the laboratory, but in more direct industrial uses. Calcium peroxide is a somewhat analogous compound which is insoluble in water but liberates oxygen upon heating. The proposed uses are for sterilization, the preservation of foods, the aging of liquors and for therapeutic purposes. Magnesium peroxide may be used in similar manner and for similar purposes. Zinc peroxide is proposed as an antiseptic dressing. Sodium perborate is another of these new compounds which is to be used for generating hydrogen peroxide for bleaching.

The electrolytic production of chlorine, bleach and alkalis reached a stage of development some years ago when it became

an object to find a market for all that could be produced by existing methods, rather than to devise improvements of existing methods. In spite of this condition improvements of methods have been made, and one of the most radical and promising of those which are now being tried is the new Townsend method which uses oil as an essential part of the diaphragm for separating the products.

THE ELECTRIC FURNACE.

In 1904 appeared the exhaustive report of the Canadian commission appointed to investigate the use of electric furnaces in the metallurgy of iron and steel. This has had perhaps a greater influence than any other one document in advancing the interests of industrial electrometallurgy. It has brought prominently to public attention the fact that electrical energy under certain existing conditions is capable of being commercially applied to various high—and even medium—temperature operations. While perhaps not being immediately available as a substitute for direct-heating operations such as are carried out in the blast-furnace, the electric furnace holds much promise in the heating of materials now effected by conduction through the walls of the crucible or muffle.

This report has stimulated experimental work and aroused great interest in the possibilities of the electric furnace, and in years to come the beginnings of various commercial operations will undoubtedly be traced back to it. The report bases its conclusions upon an assumption that electrical energy has a value of ten dollars per horse-power-year, which while perhaps warranted in certain localities in Europe is not warranted in this country, and if this inequality is maintained for years to come we may naturally expect the most important electrometallurgical achievements to be made abroad. We learn through the technical press that the first commercial application of electric furnaces to the manufacture of steel in the United States is at the plant recently constructed by the Halcomb Steel Company, of Syracuse, N. Y. This plant has installed the Heroult process with a capacity of eighty tons per day.

At Sault Ste. Marie Dr. Heroult, associated with Dr. Haanel, superintendent of mines for the Canadian government, is conducting extensive experiments on the electrical production of iron and steel, and the public is waiting with much interest the fulfilment of the prophecy that through the electric furnace Canada will become the most important producer of steel and iron and be able to supply this metal at a cost of from ten to fourteen dollars per ton.

Certain it is that if electricity is destined to play an important part in the manufacture of iron and steel, the metallurgy of the other metals must also be revolutionized through the use of electrical energy. Zinc offers, perhaps, the most promise among the common metals. Various experimenters in this country and abroad are working upon the electrical reduction of this metal, but no satisfactory furnace methods have as yet been devised. The work which has been done seems to show that the problem is largely a question of suitable furnace construction.

Successful work has recently been done both at Niagara Falls and elsewhere in the electrical production of chromium, molybdenum, vanadium, titanium, tungsten and other ferro-alloys. All these metals are now produced in the electric furnace and are marketed products.

The future development of the electric furnace requires marked additions to our knowledge of refractory materials. The success of various existing furnaces and the failure of many others may be attributed to the quality of the linings, and the secrets which certain manufacturers guard are those which relate to the refractory construction. Much attention is, therefore, being directed to the study of materials capable of withstanding the highest temperatures without decomposition or fusion. Magnesia, which where suitably shrunk is perhaps the most refractory compound known, has received much attention, and we have been informed recently that magnesia in the form of tubes and other shapes may now be obtained.

The electric furnace is giving assistance in solving this most important problem of refractories in producing refractory materials, such as carborundum and siloxicon, which are being used successfully in experimental and certain commercial operations.

In dealing with high temperature operations we are greatly handicapped by deficiency of knowledge of specific heats, conductivities, expansion and critical points of materials at these temperatures, but the impetus which has recently been given to investigation of these properties points to a downfall of this barrier. The pyrometer is the most useful agent in this work, and much attention is being given to it in its various forms. The recent improvements in this instrument include the production of an optical pyrometer capable of measuring temperatures as low as 620 degrees. The thermo-couple pyrometer has not increased its range materially beyond 1,600 degrees, though for temperatures below that value new couples have been introduced consisting of alloys of nickel, cromium and similar high-melting-point metals, having as their merit the low price at which they can be furnished.

ELECTROPLATING.

In the branch of electrochemistry which embraces the electroplater's art, we can scarcely look for revolutionizing developments. The field is, however, an attractive one to the experimentalist, and many problems await solution, including those which simplify the operation of a plating cell, improve the quality of deposit and increase the rapidity of deposition. Labor constitutes the main item of cost in electroplating. During the past year there has been a large increase in the use of the rotating basket, which while making the plating slower, greatly reduces the labor necessary for handling small work. The sand blast, as a method of cleaning and preparing the work, has also come into more general use.

Electrogalvanizing has been making rapid progress, although it has not invaded the field of the hot galvanizing method to a great extent. Mr. Anson G. Betts has recently worked out improved methods for plating with lead and antimony and thereby added these metals to the ones of use to the electroplater. The discovery of enormous deposits of cobalt in Canada will undoubtedly serve to lower the price of that metal and allow its more general use in the plating room.

BATTERIES.

Storage batteries may be divided into the lead and non-lead types. The latter are still in the experimental stage, awaiting the advent of the improved Edison cell as a competitor of the lead cell. Aside from nickel and iron, cadmium is the material to which most attention is given by those who would devise a new lead cell.

The practice in stationary battery work has of late undergone little change. The past year has yielded its usual crop of new cells for vehicle service and the tendency appears to be toward some form of Planté plate for the positive, the pasted negative being satisfactory. For this portable service the more insistent demand at the present time is not so much for reduction of weight as for durability, though in both respects there is much to be desired.

Telephone Development in New York City.

In the first rank of industrial development during the past year the tremendous increase in the number of telephones installed by the New York Telephone Company in the boroughs of Manhattan and the Bronx forms a striking example of the widespread use of telephones in New York city. In the other three boroughs of the city the growth has been correspondingly large, and in these boroughs the New York & New Jersey Telephone Company has met with a development which was not anticipated at the beginning of the past year.

The growth of the telephone system in Manhattan has been particularly constant during the last twelve months, although the last few months have seen a somewhat higher increase in new telephones than at the beginning of the year. Over 35,000 new telephones were contracted for during 1905 in the boroughs of Manhattan and the Bronx; figures which have never been reached before and which, in fact, were not fully anticipated twelve months ago.

New York is not the only city in the country where a large increase in the extent of the telephone system is being made. In fact there seems to be a wave of telephone development from one end of the land to the other, and it is only natural that New York should take a commanding position in the rapid increase in the use of telephones.

The distribution of the growth has been fairly even throughout the length and breadth of Manhattan island, but it has been particularly heavy in comparison with other years in the residential section, especially in the vicinity of Central Park and in Harlem. A number of factors have contributed to this growth, among which is the reduction in rates which went into effect in May and June and applied to all classes of service which were then offered.

The opening of the subway also had a marked effect on building operations in the northern part of Manhattan and in the Bronx, and accordingly a large number of apartment houses were planned for and built, most of which provided for a complete system of telephones operated through the popular private branch exchange system—each room being equipped with a telephone. More than 500 apartment houses now have private branch exchange systems, providing for over 15,000 telephones. Every hotel in Manhattan of any prominence has a private branch exchange system with a telephone in each room and adequate booths in convenient places for the use of the telephone by the public. More than 160 hotels are thus equipped containing over 2,000 telephones. In order to accommodate this present growth and to anticipate for the future, four new exchanges in Manhattan have been provided for and in the next year or two even more exchanges will have to be opened.

The general offices of the telephone company are located in the building extending from Cortlandt street to Dey street and known as 18 Cortlandt street and 15 Dey street. The increase in the number of employés of the company and the necessity for providing more space for office purposes necessitated the addition of a fifteen-story extension to this building on Dey street. In this new building the contract department will have new and spacious quarters and the other departments of the company which come in contact with the public will also be so equipped.

The largest gain from any one class of subscribers will undoubtedly be among the department stores, several of which have already planned for elaborate telephone systems, some of them having as high as 1,000 telephones under one roof.

The managers of the department stores realize the tremendous amount of shopping that can be done by telephone and, as the growth of telephones in the residential section has been very heavy during the past few years, most of their best customers are in a position to use immediately the new facilities which the installation of large telephone systems in the department stores will present. The presence of these large department store systems will also serve to stimulate additional residence telephone development, and not only will the large department stores welcome the idea of selling their goods by telephone, but the small retail stores will also see the tremendous advantage of personal selection of goods by telephone on the part of their customers.

While the greater part of the new telephones which will be installed during this year will undoubtedly come in the middle and upper sections of Manhattan, the business section will also experience a similar growth.

The private branch exchange system has become popular and is offered at such reasonable rates that owners of small establishments, limited to only one or two offices, are installing this class of telephone service. Business people realize that with only one telephone their business must necessarily suffer when the line is frequently reported "busy," and they gladly welcome a system which will give them more than one connection with a central office.

In looking forward to the telephone development in this city during the present year, estimates have been made which place the prospective gain in telephones at fully 75,000; two-thirds of this gain being accredited to Manhattan.

Telegraphic Developments in 1905.

During the year 1905 the most notable developments in telegraphy have been in improving the systems of the two large companies now in operation. These companies have the ground pretty well covered and are turning their attention to improved methods of transmission.

As regards the Western Union Telegraph Company, the greatest advance made is that in connection with the progress and development of the Barclay printing telegraph system. A forecast of the merits and possibilities of this system was given a year ago. At that time the system was used tentatively on lines between New York and Boston. This experience has enabled Mr. Barclay to overcome the difficulties connected with his system.

The most noteworthy feature of the development in the Postal Telegraph-Cable Company's system has been the introduction of the "Phantoplex," an invention of Mr. F. W. Jones, the company's electrical engineer. This is a system which permits the sending of an additional message over any wire, no matter whether it be in use for simple Morse or duplexed or quadruplexed messages. The system was put to very severe trials during the closing months of the year and was found to work most satisfactorily. In some cases, when all other means failed, the "Phantoplex" system was working well. In one instance reported by Mr. Jones it operated without any hitch, though the line over which the message was being sent had been wrecked.

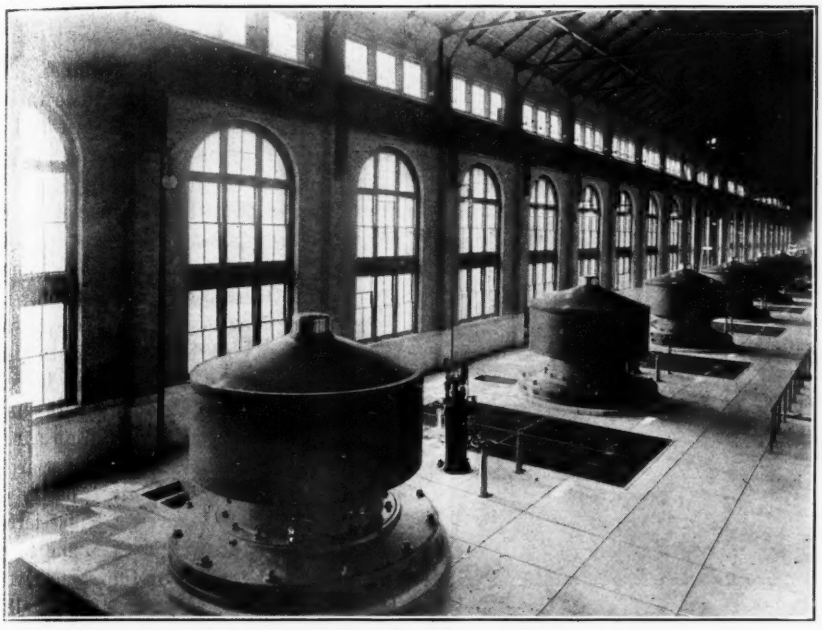
In the general development of the telegraph art the old primary battery is being displaced, and its place taken by storage batteries and dynamos. Attention is being paid to improving the older and less efficient apparatus, and overhead lines are being made stronger and better adapted to resist the stresses of the weather.

It is stated that there are 368 independent telephone companies in Indiana, 15,000 resident stockholders, 175,000 subscribers, 1,560 toll offices, $15,000,000 invested, with gross earnings last year of $3,500,000.

Some Power-Station Developments in 1905.

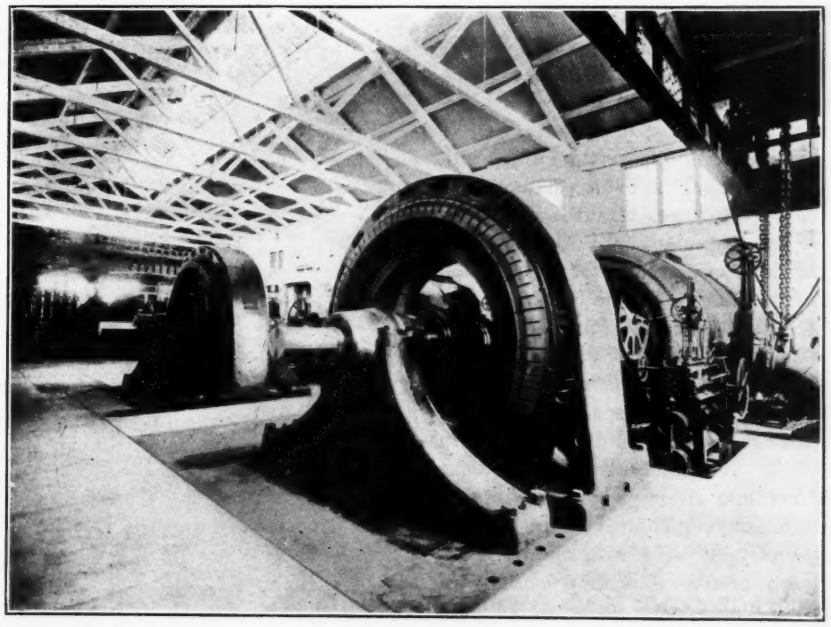
By Franz Koester.

WITH every advancing year electricity breaks its way deeper into all branches of industrial enterprise. To supply the necessary power to various distant consumers economically high-tension current, usually alternating current, is generated at central stations and transformed at numerous substations from where a suitable voltage is fed to motors and lights. Direct-current stations are to-day comparatively seldom installed, due to the small distribution systems which they are capable of supplying. Different is it in the case of alternating-current stations. With the increase of the demand stations have naturally increased in size with higher voltages, thus supplying larger areas of distribution, so that stations of 100,000 horse-power and higher have recently been erected, some of which are still under course of construction. Owing to the greatly increased capacity of central stations the size of the individual prime movers has also been markedly enlarged. This may be said not only in regard to steam-power plants, but may also be said with respect to water-power plants and of late to gas-engine power plants.



INTERIOR OF POWER STATION NO. 2, NIAGARA FALLS POWER COMPANY, NIAGARA FALLS, N. Y.

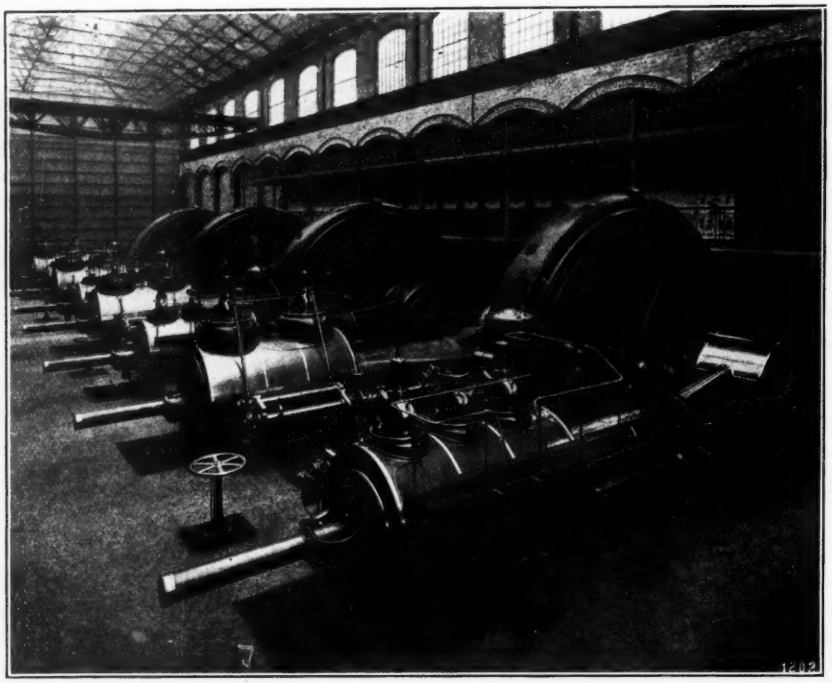
Utilization of water powers, both here and abroad, have never made such rapid strides as in the last year, notably at Niagara Falls, where all the plants completed as well as under course of construction aggregate more than 600,000 horse-power. There are on the American side, in addition to plant No. 1 of the Niagara Falls Power Company, already installed several years, plant No. 2 of the same company with more than 60,000 horse-power capacity, and plant No. 3 of the Niagara Falls Hydraulic Power and Manufacturing Company, still in course of construction, which will have an ultimate capacity of more than 100,000 horse-power. Plant No. 2, located on the south side of the canal built to supply plant No. 1, is equipped with 5,500-horse-power units, while the last-mentioned plant is located at the edge of the gorge below the new arch bridge and is equipped with fourteen 7,500-horse-power turbo-generator sets. This plant draws its water supply from a forebay fed by the old hydraulic canal, which has also supplied for some eight years power to plants 1 and 2 of the same company through a number of penstocks 8.5 feet in diameter leading down the cliff to the turbines, the tail-races leading directly into the gorge. It must, however, be stated that this plant is still under course of construction. The plant of the Canadian Niagara Power Company is practically completed, with an equipment of ten 7,500-kilowatt turbo-generators. These units, which represent approximately 12,500 horse-power each, are, to the writer's knowledge, the largest ever put in operation. They are of the two-wheel Francis vertical type, after the design of the Escher Wyss Company, of Zurich, Switzerland. At present there are only five units installed which are sufficient for the existing demands. The generators are of the General Electric Company's 11,000-volt, twenty-five-cycle, three-phase type. Another plant recently put in operation is that of the Ontario Power Company, lying at the left edge



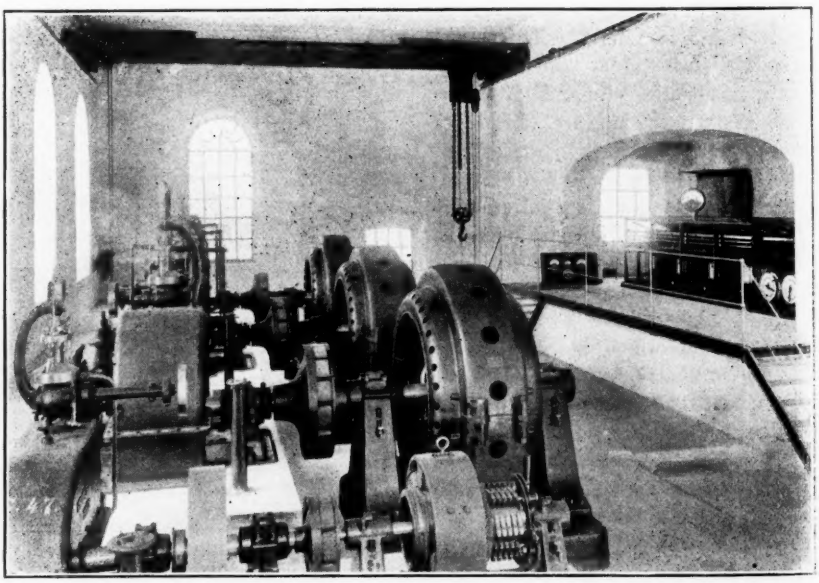
DYNAMO ROOM, WASHINGTON WATER POWER COMPANY, SPOKANE, WASH.

of the gorge below the Horseshoe fall. The ultimate total capacity of this plant will be some 180,000 horse-power, although there are to-day only five 7,500-kilowatt units in operation. A noteworthy feature is that the entire building is of reenforced concrete. The water is drawn from the river above the falls and leads through eighteen-foot penstocks down to the power-house. Another Canadian plant is that of the Electrical Development Company, of Ontario, still in the early stages of construction, which will, when completed, have an equipment of eleven 8,000-kilowatt turbo-generators. Other recently completed hydraulic power plants in America are the Washington Water Power Company at Spokane, Wash., the Guanajuato Power and Electric Company and that of the Mexican Light and Power Company, of still more importance than the former as it is the greatest water-power development in Mexico, utilizing the waters of the Nécaxa and Tenango rivers in the province of Huauchinango. This latter equipment will consist of two plants, one of which is nearly completed, with a capacity of six 7,000-horse-power units, while plant No. 2, lying below, will utilize the tail-race water and the falls of the Tenango, and will also develop some 40,000 horse-power. As these plants are in a previously inaccessible location a new road had to be built for the transportation of some 35,000 tons of machinery and construction material for power plant No. 1 only, and to build the dam, harnessing the water and drive the head-race tunnels and equip the plant some 2,300 workmen were employed. Such enormous undertakings in harnessing water for the purpose of generating electricity are unknown in Europe, and the plants which have there been erected during the last year, although very numerous, are of comparatively small capacity. Switzerland, as it has done for a number of years, took the lead in this direction, utilizing the water of many mountain lakes and streams, among which may be mentioned the plant La Dernier, utilizing the water of the river Orbe, equipped with five 1,000-horse-power turbo-generators. The turbines are of the Pelton wheel type and the ultimate equipment will consist of ten such units. The generators are of the Oerlikon 13,000-volt, three-phase, fifty-cycle type. Another recently installed prominent plant is that at Zoguo, utilizing the water of the Brembo in Italy, equipped with four 2,000-horse-power Francis turbines, the horizontal shaft direct-connected to three-phase, 2,600-volt alternators. In utilizing the power of the river Bourne a plant has been erected in the valley of the Bournillon in France with an equipment of 1,000-horse-power units and 3,500-volt alternators, this voltage being stepped up to 35,000 volts for transmission. A prominent plant has been built in Norway near Christiana at Kykkelsrud, utilizing the water of the Glommen, the largest river in the country. This plant is similarly built to that put in operation a few years previously at the town of Sarpsborg, which has an ultimate capacity of some 25,000 horse-power. This latter plant is also located near the same town and utilizes the water of the same river. The new plant has at present an installation of four 5,000-horse-power main units composed of Schuckert generators direct-connected to Echer-Wyss and J. M. Voith turbines. The ultimate capacity will, however, be some 54,000 horse-power.

Great Britain and Germany, being not in possession of so much water power, have naturally turned their attention to steam-driven central stations. One of

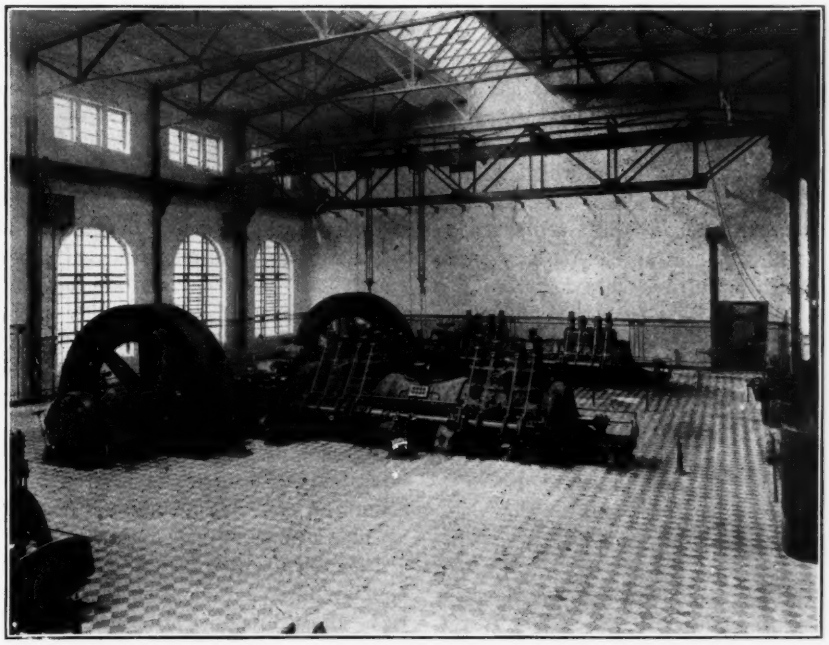


BOW STATION, CHARING CROSS CITY ELECTRIC COMPANY, LONDON, ENGLAND.

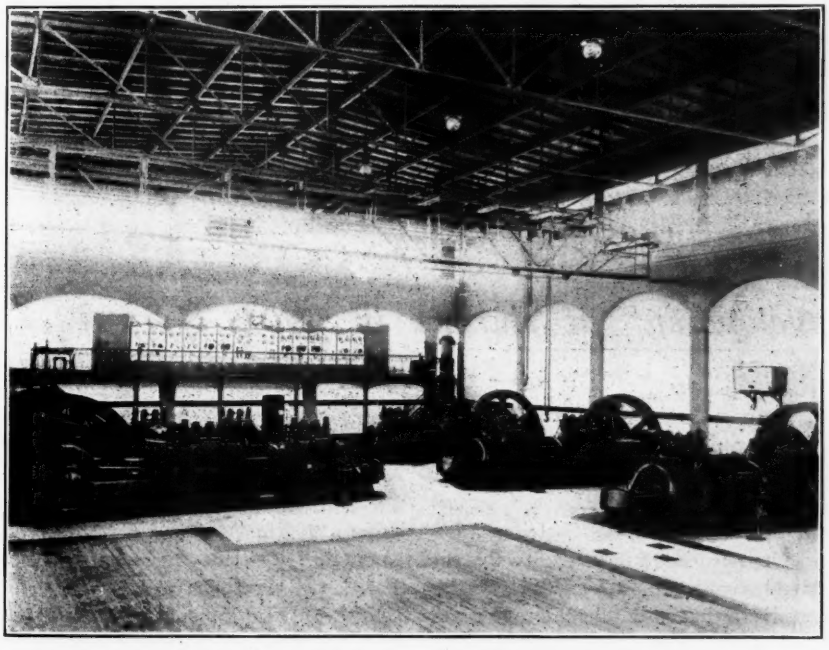


HYDROELECTRIC PLANT OF THE 40,000-VOLT TRANSMISSION SYSTEM, GROMO-NEMBRO, IN ITALY.

the foremost stations completed in the last year is that of the Chelsea plant at London, England. This plant is equipped with eight 5,500-kilowatt turbines of the British Westinghouse company, while another plant, also equipped with the same type of turbines, is the Neasden station with four 3,500-kilowatt units. Other prominent plants in England are Sheffield-on-Tyne, Motherwell and the Yoker stations; while France has still under course of construction the plant of St. Denis near Paris equipped with four 5,000-kilowatt Brown-Boveri-Parsons turbines. This plant will, when completed, be unquestionably the most up-to-date plant yet built, as the entire auxiliary outfit is motor-driven, a practice which has existed for several years on the Continent of Europe, but has been seldom carried out in such extreme detail. In a plant in the city of Essen, Germany, have been erected two 10,000-horse-power Brown-Boveri-Parsons turbines operating upon a common condenser. The low steam consumption of this type of engine, obtained on the Continent, is remarkable, as units running under normal conditions produce an indicated horsepower with nine to nine and one-half pounds per hour, while ten pounds is often considered high. In this country many prominent plants have been completed in 1905, while some are still under course of construction. There are, for instance, the now practically completed Interborough Rapid Transit Company's new power plant supplying both power and light for the operation of the new underground road. This plant is equipped with nine 8,000-horse-power, cross-compound Allis-Chalmers-Corliss valve engines, drawing saturated steam at 175 pounds pressure from some sixty 600-horse-power of Babcock & Wilcox boilers. It must, however, be stated that a few of these boilers are equipped with superheaters, supplying steam to three 2,000-horse-power Westinghouse-Parsons turbines. Other prominent plants are also under course of construction, as that of the New York Edison Company, the Water Side station No. 2, where the largest size of Curtis and the Westinghouse-Parsons turbines will be installed, the New York Central & Hudson River Railroad Company plants in which 5,000-kilowatt Curtis turbines will be used, the Philadelphia Rapid Transit Company's Delaware avenue station, where six 7,500-kilowatt and two 6,000-kilowatt Westinghouse-Parsons turbines are being installed. The boiler house of this latter plant will be equipped with forty 800-horse-power Parker boilers placed in eight rows at right angles to the axis of the turbine room, each row being provided with its own smokestack. This practice is one of the most radical changes made in recent years in regard to the relative location of boilers and generating rooms, a practice adopted simultaneously in Europe and America. This is a natural result of the small space occupied by the turbines as compared to that required for the boilers, and makes a more compact and better system of steam piping possible. Another improvement of late years is that of using steam pipe of smaller diameter which, while not very prevalent in America, is much favored in Europe where higher degrees of superheat are more commonly used, which allows a greater velocity than saturated steam. This utilizes more completely the advantages of superheated steam, as with this increased velocity the drop in temperature is very materially lessened, a decided ad-



GAS-ENGINE-DRIVEN ELECTRIC PLANT, DORTMUND, GERMANY.



GAS-ENGINE-DRIVEN ELECTRIC PLANT AT SCHEVENINGEN, HOLLAND.

vantage well worth the few pounds of pressure lost by friction.

The use of motor-driven auxiliaries has already been touched upon, and it may be stated that the practice tends to a more general adoption, especially for the condenser equipment. Although not in very common use in this country it has long been in extensive use on the continent of Europe. Doing away with the steam pumps, the exhaust from which is generally used for boiler feed-water heating, economizers are installed utilizing the waste surplus heat of the flue gases, also a feature more commonly found in Europe than in this country. There are numerous smaller detail features found in the power plants on the Continent of Europe, practically unknown in this country, which all add much to the lower steam consumption and more efficient operation of the entire plant.

A newer and altogether more important factor in power-plant design is the introduction of the gas engine, although the earlier gas-engine plants have been installed in connection with blast-furnaces, coke ovens, etc. In the last year several plants have been installed as purely electric stations furnishing current for railroading, power and lighting. The individual gas-engine units, as built to-day, are nearly equal in capacity to our most up-to-date water or steam prime movers and far more efficient. There is, therefore, obviously a great field open for this type of prime movers. Several large plants of this character have recently been built on both sides of the Atlantic and there are to-day a number of manufacturers, especially in Germany, who have taken up the design and construction of these engines, which, of course, leads to the various types, some of which have been adopted in this country by prominent concerns. The largest gas-engine power plant to-day in operation is that of the Lackawanna Steel Company, at Buffalo, equipped with sixteen 2,000-horse-power two-cycle Koerting gas engines, as installed by the De La Vergne Machine Company. These engines are operating blower engines of vertical type. In the same company, at Buffalo, there are a number of 1,000-horse-power Koerting gas engines direct-connected to three-phase alternators and continuous-current generators. All these engines are operated with blast-furnace gas. Another prominent plant is that of the California Gas and Electric Company, where three 5,000-horse-power gas engines are reported to be in operation. Earlier prominent European installations utilize in most instances the waste gases in iron mills, foundries, etc. There are, for instance, at the Krupp works, Friedrich-Alfred-Hütte, Rheinhausen, two Nuremberg gas engines of 1,200-horse-power capacity, each direct-connected to continuous-current generators operating 100 revolutions per minute, while two other units of the same type, but of 1,600-horse-power-capacity, operate blower engines. These latter units run at twenty-five to eighty revolutions per minute, and are capable of supplying 1,000 cubic feet of air at seven and one-half pounds pressure per minute. Another recent plant is that of the Sociedad de Gasificacion Industrial, Madrid, equipped with six 2,000-horse-power Nuremberg engines, direct-connected to 3,000-volt alternating-current generators, operating with producer gas. Another plant is that at the mining works of the Dortmund Actien Gesellschaft Consolidation, with 680-horse-power Nuremberg gas engines direct-connected to three-phase alternators, while a smaller unit of 160 horse-power is direct-connected to a continuous-current generator. These engines operate with coke-oven gas. Besides the above-mentioned quality of gas, there are a number of plants operating with illuminating and natural gas. However, those using illuminating gas are of smaller capacity, while that of natural gas are limited in the locality in which they can be used.

All these examples serve to show the rapid advancement made in gas-engine practice during the last year and it will probably be not long before a number of plants are seen in the vicinity of large cities furnishing power for urban railroads, lights and general public service. An example of such a plant is the station of the Scheveningsche Elektriciteit Maatschappij, at Scheveningen, Holland. These gas engines, as well as the above-mentioned Nuremberg engines, are designed and manufactured by the Maschinenbaugesellschaft, Nuremberg, Germany, which is the originator of this type of engine, which is four-cycle. A prominent two-cycle type in Europe is that of the Oechelhaeuser system, as manufactured at the Borsig works in Berlin, with which a number of prominent plants have recently been equipped, and units up to 4,000 horse-power are now under course of construction.

Whatever type of plant is constructed, may it be water, steam or gas, the most noticeable tendency is to install a single central station in place of the numerous small plants equipped with large individual high-capacity units, supplying power to numerous consumers.

Electrical Development in Europe in 1905.

By C. L. Durand.

WE FIND a considerable increase in the number of power stations on the Continent during the past year, both as regards steam and hydraulic plants. We may mention a few of the hydraulic stations which are in operation or which are to be installed in the near future. The north of Italy has had a number of new plants erected. The Caffaro station, which lies in the province of Brescia, near the Austrian frontier, sends current to Brescia to the extent of 2,500 kilowatts over a thirty-mile line. The voltage is 40,000. The region of Gallarate and Legnano is supplied at present from three large hydraulic plants. The Vizzola station furnishes 12,000 kilowatts and has 160 miles of lines. The Turbigo plant gives 3,500 kilowatts. Both these stations lie on the Tessin river. At Castellanza is a third plant of 5,000 kilowatts. To this extensive system is soon to be added a fourth hydraulic station on the Poschiavano river, having 40,000 horse-power. At Zogno, in the Brembana valley, is a station which has been erected by the Conti company, using Italian-made apparatus to the amount of 6,000 horse-power. The same company is operating a plant on the Tessin at Vigerano of about equal capacity. On the Adda river a 7,000-horse-power plant is in construction at Trezza. A Milan company has obtained a concession for a station on the Anza river, using a 400-foot fall, and will operate a power line to Milan. The municipality of Turin will shortly erect a plant on the Doire river for supplying the city circuits. In Switzerland we find considerable progress in this direction, although there have not been so many new plants erected. The Compagnie de l'Industrie Electrique, of Geneva, has added some machines to the Vouvry hydraulic plant, which has a 3,000-foot fall. One of the recent Swiss

projects relates to utilizing the Maira river for a large plant, and upward of 10,000 horse-power can be obtained. The Mediterranean coast region of France now has several large hydraulic plants. These are used for Nice, Toulon, Cannes and other localities on the coast. To the stations of Mescla and Loup, the Thomson-Houston company has added a third plant at Plau du Var. These stations all use three-phase current and can be connected together on the same lines. Lyons is to receive current from a new station at Moutiers over a 112-mile line, which is the longest in Europe. The Thury direct-current system, supplying 6,500 horse-power, will be used. A new company has been formed at Paris for operating a hydraulic system in the valley of the Bienne, while a second company is to utilize the Ance river for a large plant. A number of new stations are to be erected in the Grenoble region. Among the hydraulic plants installed by the Westinghouse company we may mention the station near Clermont-Ferrand, on the Sioule river. Sweden and Norway are commencing to utilize the large amount of water power which is at hand. The Drammen plant in Norway uses a forty-five-foot fall and operates a 20,000-volt three-phase line. The Swedish Electric Syndicate has been formed for operating a vast enterprise in the south of Sweden, including a number of stations. The first project is to use seven plants on the Lagan river near Halmstad and a system of lines 200 miles long. Starting with 13,000 horse-power, it expects to double this capacity.

Among the new steam-operated power plants we may mention the large station which is building in the neighborhood of Paris at St. Denis. It is to be one of the largest plants in Europe, and will be operated entirely by steam turbine groups of the Brown-Boveri-Parsons type, built in Switzerland. These groups, of which there are three installed, will give 10,000 horse-power each and deliver 10,000 volts three-phase current. The large Metropolitan station of Paris has had its capacity more than doubled in order to supply the new subway lines. The Thomson-Houston company has erected three upright groups which have Corliss engines and alternators of 2,100 kilowatts, delivering 5,000 volts, and a fourth group is to be erected. At Marseilles a large plant of 7,000 kilowatts is to be put in by the same company for the city circuits. In Germany a 7,500-horse-power Brown-Boveri steam turbine set has been installed at Essen, and a 10,000-horse-power group at Mannheim.

In regard to the progress of electric traction we may consider the electric railroads of standard gauge track which have been installed, also the use of electric trains upon certain sections of the main railroad lines, besides the projects for long or high-speed railroads. As to the electric railroads which are now running, we note the Amsterdam-Haarlem road, which is sixteen miles long and uses forty large motor cars carrying two fifty-horse-power motors. The trains use the 500-volt overhead system with an arched trolley. Current is supplied from a station located half-way along the line. The Valtelline road in the north of Italy has greatly increased its traffic, and is now running trains which are made up of a motor car or locomotive of fifty-five tons and four or five trailers. In the region of Paris the new electric road running from the city to Versailles is working very successfully, and as the line is shorter it has taken a good deal of traffic from the steam railway. On the Orleans railroad electric trains are now running to provide for the suburban traffic as far as Juvisy, twelve miles distant. Special tracks have been laid along the railroad for the electric cars. The latter can thus enter the city and run upon the existing tracks along the Seine to the new station in the centre of town. Locomotives and motor cars supplied by the Thomson-Houston company are used here, with the 500-volt direct-current system. One of the most successful electric roads in Switzerland is the twenty-five-mile line running from Berthoud to Thoune. It is equipped on the Brown-Boveri three-phase system, using a trolley wire at 750 volts. On each of the motor cars are mounted four three-phase motors of seventy horse-power, while the freight locomotives carry two 150-horse-power motors. In Sweden the government is testing a 300-horse-power Westinghouse locomotive on the single-phase system, as it is desired to use electric trains on the railroad lines.

Some of the projects for electric railroads may be mentioned. In Germany a high-speed electric line to connect Berlin with Hamburg is one of the most important projects. It is proposed to use express trains at a speed of eighty or ninety miles an hour. A Belgian project relates to a line from Louvain to the German frontier, which is to run trains at eighty miles an hour and shorten up the time from the German railroads to Brussels. In Sweden a movement is on foot for operating an extensive electric railroad system in the southern region by hydraulic power. The Mediterranean coast line in the south of France proposes to run electric trains from Cannes to the Italian frontier, and is now experimenting with a new form of locomotive. The Westinghouse company is to run a thirty-two-mile electric railroad from Rome to Civita Castellana on the 6,000-volt system, and another line from Bergamo to Valle Brembano. The Austrian government expects to run electric trains upon the railroad lines, using hydraulic power.

Most of the new inventions in arc and incandescent lighting have been made in the way of incandescent lamps having the filaments formed of different metals. The manufacture of the tantalum and osmium lamps has been considerably improved during the year. The Siemens & Halske company already reports a large sale of its new tantalum lamps. The osmium lamp, which at first could not be made to work above thirty-seven volts, now has an improved filament which will run on a 110-volt circuit. Zirconium is used by Professor Wedding for lamp filaments. He claims that the lamp consumes two watts per candle-power and the life is about 1,000 hours. The zirconium mineral is found in Ceylon, New Zealand and also in America. As to mercury-vapor lamps, one of the new forms is the Uviol lamp, so-called because it gives a large proportion of ultra-violet rays. It is made by a glass works at Jena. A new system has lately been brought out in Germany, known as the "Orthochrome" lamp. Its object is to supply the absence of the red rays. To a mercury-vapor lamp is added an ordinary incandescent lamp and the combination gives a nearly white light. Among the arc lamps we may mention the new Blondel arc which has lately appeared in Germany. The carbon is treated with magnesia and fluorides. When running on five amperes and forty-six volts it gives 1,200 candle-power, with a yellowish light.

In the field of electrochemistry we note a number of new electrolytic processes, either on an experimental or an industrial scale. The Carbide Society, of Gurtnellen, expects to go into the manufacture of steel, using the Kjellin process, and has increased its capital for this purpose. It expects to start up very soon with a 500-horse-power furnace at first, but will then increase the capacity. Another German firm, the Röchling Steel Company, decided to begin the production of steel, using the same system, commencing with a 1,500-horse-power furnace. In Italy the Stassano electric furnace for producing steel is now being operated by the government at the Turin arsenal. One of the most successful processes in France is the

Gin system of electric furnace, which, besides other metals, will give a high quality of iron or steel which contains no carbon. Vanadium is one of the metals which it produces. The electric furnace process for glass is now in use in Germany by the Plattenberg glass works in Westphalia. The Becker process is employed here, and the furnace has a capacity of several thousand horse-power. It is said to take one kilowatt-hour per kilogramme of glass. The new Schwerin electric peat process is said to be very successful. The peat is treated by the current while spread upon a wire-gauge frame and the water is quickly expelled, after which the machines compress it into blocks for fuel.

As regards the progress in telephone matters, the opening up of the Paris-Rome telephone line, which is one of the longest in Europe, is one of the principal events of the year. At Vienna the American Strowger system is on trial in central station No. 2. It has been installed by a German company. The Bavarian administration, owing to the success it had with the central battery system at Ludwigshafen and Neustadt, is to install two stations of the same kind at Würtzburg. The material is supplied by a Berlin firm. The common battery system is now applied in the stations of Trieste and Carlsbad. We note two new forms of microphone. Signor Angelini, of the Rome station, has invented a new granulated carbon form with which he was able to speak with the Brussels station, a distance which could not be reached with ordinary instruments. The new Majorana transmitter works on the principle of vibrations produced in a liquid stream or jet, which modify the current. It is said to allow a very high current to be used.

In the way of telegraphy we note the opening up of several new submarine cables. One of these connects Costanza, in Roumania, with Constantinople, and completes the line from Berlin. A new cableship is building which is to replace the Podbielshi. It is owned by the company which controls the Nordenham cables in Schichau, Germany. As regards the new telegraph and telephone cable which is to pass through the Simplon tunnel, the Swiss and Italian governments have come to an agreement by which each will bear the cost of the cable on its own territory. The Swiss government has allowed a credit of $50,000 for this purpose.

Wireless telegraphy is a branch in which we find the greatest activity during the year. Two large experimental stations are now operating between the suburbs of Berlin and the city of Dresden, covering 100 miles distance. These stations are carried out on the most extensive scale, and are to be made the basis of future work. They are said to have cost $120,000. In France the minister of commerce decided to organize a special service of wireless telegraphy and proposed to the war department to have three coast stations erected at Cherbourg, Toulon and Bizerta. Experiments are being carried out between the Eiffel tower at Paris and the Chalons military camp; also between Sainte Menchould and Verdun. The two French coast stations of Wissant and Porqueralles are now in operation. Different forms of apparatus are being tried, but none will be definitely adopted before the Berlin congress of next year. The telegraph department of Hungary is working two stations at Csepel and Leopoldau, near Vienna, a distance of 150 miles. One of the largest of the German stations is located at Norddeich, in the northwestern part of the country. It is equipped with specially powerful apparatus and at present is able to work to a radius of 1,000 miles. The mast towers are 220 feet high. The station communicates with Saragossa, Naples and St. Petersburg. The Turkish government is to establish a station at Rhodes and a second on the coast of Tripoli which will work at a distance of 400 miles. Siemens & Halske apparatus will be used here. A system will soon be operated between Iceland and the Continent. It will use either Marconi or the Telefunken apparatus.

Electrical Patents in 1905.

By E. G. Siggers.

THE year 1905, insofar as the patent office is concerned, has been a record-breaker, and this has been true in the field of electrical inventions as well as in every other art. It appears that there has been no great departure from the beaten track, however—no generic patents to startle the world and revolutionize any line of industry.

There are three divisions in the patent office given over exclusively to the consideration of applications relating to the electrical world, and a general estimate would place the number of applications for patents now pending in these divisions alone as somewhere between 7,000 and 8,000, whereas the number of examiners allowed such divisions is only twenty-one. It will therefore not seem strange that it requires from two to eight months to reach an application and secure an official action thereon after the same has been filed, though by dint of hard work the electrical divisions have never more than 2,000 cases awaiting their action, the remainder of the applications awaiting amendments on the parts of the applicants or the attorneys. In this connection it is certainly not out of order to note the fact that the patent office is the only self-sustaining and earning institution under the government, and is yearly adding to its fund of over $5,000,000 net gain now lying in the treasury. Yet Congress refuses to afford relief for the congested condition of affairs and will not increase the facilities for transacting business, notwithstanding the enormous increase in the applications being filed and the consequent work to be done.

In the division of electricity that handles generators, motors and the like, the alternating-current motors appear to stand at the head in the march of improvements, though inventions in the line of details of all other classes are not forgotten. The division having charge of electric lighting apparatus reports great activity in mercury-vapor lamps, and closely associated therewith are the mercury-vapor rectifiers. The first patents on these were granted during the past year. The rectifiers are based on the discovery that the impulses of an alternating current can only pass in one direction through a mercury-vapor lamp, the opposite circuit being snuffed out. Consequently if an alternating-current generator is connected to one of these lamps, a direct current only will flow therefrom. This is now being carefully worked out, and enormous advantages of an important nature are being derived therefrom. Arc lamps also are receiving a great deal of attention, particularly the enclosed arcs and the flaming arcs. In the latter, gas or vapor-forming substances are incorporated in the carbon,

and this gas or vapor, when produced by heat, acts as a conductor to make a long arc having more light than the old carbon with the same amount of power. Incandescent lighting is also very active, particularly the so-called "Nernst" or glower lamps.

Important advances are being made in car-lighting systems, and particularly the means for regulating the currents. The difficulty to be overcome in this line is obvious, when it is considered that the generators are driven from the car wheels, and the speed of the latter varies from zero to sixty miles an hour. Automatic switches of various characters are provided for throwing the lamps into circuit with the generators when the same have reached sufficient speed, or into circuit with storage batteries, when the speed of the generator is below normal. Automatic mechanical regulators have been provided for controlling the varying amounts, and now even these are being eliminated, and arrangements are being perfected and patented whereby the variations and opposing actions of the circuits counteract and control themselves in order to supply an unvarying current to the lamps.

In the classes of telephony and telegraphy great activity is being shown. The latter includes electrical indicators of various sorts for indicating speed, signaling and the like, and the term as used in the patent office is of much broader significance than as employed in the commercial world. Of course wireless telegraphy is interesting numerous inventors, and the past year has seen many improvements perfected. The art, however, is yet in its infancy. In telephones the automatic exchange system appears to be at present a fertile field, and long strides have been made in this branch. At the same time the "hello girl" system has not been forgotten, and refuses to be classed as a back number.

Of course among the thousands of applications that have been passed and are being passed through the patent office numerous freak inventions are found. There is still the man that proposes to lift himself by his boot-straps, and the perpetual-motion crank is always breaking out anew. For instance, it is no rare thing to have an endless chain invention of the following character presented in an application for the consideration of the patent office examiners. Some erudite inventor will propose to take an engine and run an electrical generator with it. The current derived from this generator is employed to heat an electrical heater. The heater in turn heats the boiler which supplies the steam to the engine and the extra current derived from the dynamo, not needed to operate the heater, is employed for lighting or any other purpose desired. The patent office has a simple and convenient method of disposing of these cases by requiring a working model. Ordinarily they are never heard from again.

In brief, it will therefore be seen that every line in the art of electricity is receiving its full share of attention and is continuously being improved by the apprentice who has blundered upon a new idea, by the skilled artisan and by the professional inventor, and no advance appears to be too trivial to protect by a patent or at least to have the attempt made.

Directly associated with the patent office matters is the registration of trade-marks, and great changes have been made therein during the past year. A short statement of the same may be of interest.

In 1881 Congress passed a law providing for the registration of trade-marks used in commerce with foreign nations and Indian tribes, but for some inexplicable reason failed to include those used in interstate commerce. In construing this law the supreme court quite recently decided that in order to infringe the registered mark and come within the provisions of the act it was necessary for the infringer also to employ the mark in commerce with foreign nations or Indian tribes. In fact, the law was defective in many respects and afforded practically no protection, therefore a new statute was passed in 1905.

One of the particular features of the new law is that trade-marks used in interstate commerce can be registered. As very few articles are not sold at least in two states, an enormous field is thus opened. But there are other important advantages now secured by the registration of trade-marks. Among these the new statute is undoubtedly more liberal than the patent office has heretofore been as to what constitutes a valid trade-mark, and it affords the right of appeal from the unfavorable decisions of the patent office to the court of appeals, thus giving the final decisions to a court of three judges instead of one man. It is hoped that no illiberal practice as to registration will now become established. Also if another than the real owner should register a trade-mark, ways are provided wherein the wrongful registrant may be ousted in favor of the rightful owner. The term for which registration is in force is now fixed for twenty years, with the privilege of extending the time. A very important feature is that the right of action in the United States courts is given against an infringer who uses the mark in interstate commerce.

These and other provisions, it is believed, will now secure adequate protection for all manufacturers and sellers of goods, wares and merchandise who have their trade-marks registered under and in accordance with the provisions of the new law.

Electricity in Sweden.

Consul Bergh, of Gothenburg, reports that several of the old railway systems of Sweden are planning to substitute electricity for steam as motive power, and that plans are being considered to apply electricity to a canal recently purchased by the government. He says:

"The Helsingborg Raa-Ramlösa railroad (five miles) is now being changed to use electric power. A power station is under construction in Helsingborg. The power is obtained from three suction gas engines, each of 100 horse-power, with peat as fuel. The power station is built by a Swedish firm which has the patent rights on said motors, which are said to be very economical in use. The owners of the Gothenburg-Särö railroad (fourteen miles) have called for and received plans for the adoption of electric power for that road. The intention is to take the power from Yngeredsforsen, near the city of Falkenberg, by high-tension transmission, with a transforming station about six miles from Gothenburg. Three or four new short electric railroad lines near Gothenburg are also planned. It is reported that the cities of Skara and Lidköping and certain companies are negotiating for electric power from Vargöns Aktiebolag, at Trollhättan. The plant shall, to begin with, have a capacity of 1,500 horse-power.

"The board of finances for the city of Lund has in a communication to the city council recommended the building of an electric power station in said city, and the so-called committee of electricity has recommended that the city should build electric street railways which should take the necessary power from said power station.

"Since the property of the Trollhättan Canal Company was purchased by the government the new board of managers was instructed to investigate the plans for a large electric power plant at Trollhättan. Three engineers are working on plans which are not expected to be finished and submitted to the Riksdag before the year 1907. It is calculated that it will require three or four years to build the power station, and that the cost will not exceed $38 per effective horse-power. As the water power at Trollhättan is large it is considered that certain Swedish industries will derive great benefit from the plant when built."

Washington to St. Petersburg—Overland.

By George C. Maynard.

THE flag of the Mayflower waved and fluttered in the ocean breeze, disappeared from sight beyond the far, billowy horizon, and left the little group of watching colonists on Plymouth shore in heart-breaking loneliness. Hardship, privation, death, they were prepared to meet and their courage never faltered, but to feel the breaking of the last link that bound them to home and kindred, to gaze out upon the illimitable ocean and realize that across the boundless space no word could pass, this was the trial hardest to bear. Nearly two and a half centuries later the breaking of the frail strand of wire lying at the bottom of the Atlantic, upon which high hopes had been based, thrilled the world with a feeling of profound disappointment.

From the day of the discovery of the western continent, better means of communication between the new world and the old was the desire, the passion, the necessity of every day's experience. The invention of the telegraph opened visions of wonderful possibilities of instantaneous, world-wide communication. The attempt to span the Atlantic ocean with a submarine cable had been made and failed. Ten thousand miles of costly telegraph cables were lying at the bottom of the sea, abandoned as useless, and the prospect of successfully working long lines of this character seemed almost hopeless. Then came the determination to reach the old world by an overland route. The time for such an undertaking was auspicious. During four years of terrible strife the government of the United States, while bending every energy to maintain and more firmly establish the principles of its founders, never forgot the injunction, "In time of war prepare for peace."

Among the brave, far-sighted men of that time, William H. Seward was one of the foremost. "The insatiable mania for icebergs" of that distinguished American had better foundation in solid sense than any one understood. He had faith in both submarine cables and overland telegraph lines. For years he had been studying the problems involved in "putting a girdle 'round the world in forty minutes," and, with prophetic comprehension, clearly saw the desirability and the practicability of establishing a line crossing Behring sea and uniting America with Asia and Europe. Under his instructions American diplomatic officials in Russia had made thorough investigations of the physical, social and political questions bearing on the undertaking and a plan for its accomplishment was developed. This plan did not simply contemplate telegraphic connection between Washington and St. Petersburg, but was intended as an important step toward the establishment of one comprehensive system which should provide means for quick transmission of intelligence to all important points throughout the world. Seward fully realized the advantages of such a system and declared that "it is impossible to assign limits to the increase of national influence which must necessarily result from the new facilities we should acquire in that manner for extending throughout the world American ideas and principles of public and private economy, politics, morals, philosophy, and religion." The monarch of the Russian empire also had ambitious designs of providing means for reaching distant lands. Official records show that long before Seward's scheme was announced he had made plans and preparations for extending the telegraph system of his government from the mouth of the Amoor river, across the straits of Tartary, over the island of Sakhalin, across the straits of LaPerouse, through Hakodadi, and across the straits of Sangar to Yeddo, the capital of Japan. The difficulties in the way of extending Russian lines into the heart of Japan have somewhat increased since '65.

The leading spirit in the Russian-American overland telegraph was Perry Macdonaugh Collins, a citizen of California, who had spent six years in the United States service as commercial agent for the Amoor country and as acting consul at St. Petersburg. During this period he made careful study of the subject and, upon the close of his official duties, set to work to put his plans in operation. He secured liberal concessions and rights of way from Russia and Great Britain, returned to the United States and, most fortunately, enlisted the interest and cooperation of the Western Union Telegraph Company. That company had just completed a telegraph line across the vast western plains and over mountain ranges, eight thousand feet high, to the Pacific coast and, by its great experience, administrative ability and financial resources, was fully prepared to carry the line onward to St. Petersburg. Funds to the amount of ten million dollars were provided and operations were promptly commenced and vigorously prosecuted. Large quantities of wire, insulators, submarine cables and other building materials were procured, both in this country and in England, and ships for the transportation of men and supplies were purchased and despatched to various points on the northwestern coasts. In thirty days vessels from New York and Liverpool were speeding toward Cape Horn and the Isthmus, while others, selected from Pacific fleets, were gathering at San Francisco, which was made the headquarters of the expedition.

While supplies, in liberal quantities and of the best quality, were essential, the need of competent men was still greater, and these were forthcoming. Out of the Civil War period came men endowed by native qualities and stern training, with high courage and that resilient toughness of fibre, physical, intellectual and moral, which fitted them to successfully meet any emergency and overcome all obstacles. Colonel Chas. S. Bulkley, an army officer and an experienced telegrapher, was placed in command of the field work. He selected one hundred active young men as leading explorers and superintendents, many of whom were telegraph operators and engineers. Four hundred additional men were employed to do the actual work of constructing the lines, and placed under the direction of Edward Conway. Among the leaders were Franklin L. Pope, his brother Ralph; George Kennan, Frederick Whymper, brother of the famous Alpine climber; Professor Dall, of the Smithsonian Institution; George Willoughby Maynard, the artist, and other well-known men. Major Serge Abasa, a prominent and influential Russian military officer, had command of the Siberian section of the line. The names of the explorers are too many to be noted, the title of "hero" fits them all. The parties were organized on a semi-military basis, principally for the reason that this would give them a better standard in Russian territory. The officers were commissioned by the governors of several states. Bulkley was a colonel, and Frank Pope a major on the staff of Governor Andrew, of Massachusetts. Quite a number of the men held commissions from the governor of California. A spirit of high emprise and heroic adventure filled and animated the

heart of every man in the expedition. That there was a dash of danger in the work before them only made them the more anxious to begin it.

The outlook was inspiring. The building of a telegraph line, more than eight thousand miles long, through an unknown land; a thread of light weaving through the dark mazes of trackless wildernesses, blazing a way which railroads and steamboat lines should follow, the opening of new countries and the development of their wonderful resources; the civilization of the western, liberty-loving land entering the wide-open back door of ancient eastern empires, teaching the lesson of the kinship of humanity and hastening the day of universal peace! The impatient eagerness of the telegraph pioneers was fully justified.

The desire for adventure did not long remain unsatisfied. Once outside the Golden Gate there was never lack of exciting experiences. Tempestuous storms, dense fogs, rocky and uncharted shores, never in sight but dangerously near, required constant vigilance and skilful seamanship to escape destruction. To give additional zest to the voyage it was reported that the privateer Shenandoah was cruising in those waters and projectiles from her guns were always looked for. The second day out George Kennan scratched from his map the old name of the great body of water over which they were sailing and renamed it the "Terrific Ocean."

For forty-seven days the little brig, Olga, carrying him and his three companions to Petropavlovski, never saw a gleam of sunshine, but plunged and rolled through fog and fearful seas, driven furiously forward by raging hurricanes and baffled by contrary winds, guessing at its course and whereabouts. The Dutch captain of the vessel guessed right, and in the middle of one dark night hove to within twenty miles of the exact spot he was seeking, and waited for morning-light to give him a glimpse of the snow-white mountain peaks behind the harbor of St. Peter and St. Paul; and when the explorers stepped on shore they were more than a thousand miles from the nearest point on the route of the proposed telegraph line. The other vessels of the fleet passed through similar exciting experiences.

From San Francisco four main parties were sent out in different vessels. One of these, under Franklin L. Pope, went to the mouth of the Frazer river, in British Columbia, to explore the country along that stream and across to the Yukon; the second, under Robert Kennicutt, to St. Michaels, on Norton sound, to go up the Yukon valley and meet the British Columbia party, and also to locate a route northwest to Behring sea; the third party, in charge of Collins L. MacRae, was landed in Anadyr bay to explore the country westward to Behring sea and eastward up the Anadyr river to meet the men of the fourth division to which, starting in at Petropavlovski, was assigned the task of surveying the country between the Amoor and Anadyr rivers. Major Abasa was in command of the entire work in Siberian territory, with George Kennan and Richard J. Bush as his principal assistants.

Within three months from the sailing of the fleet from San Francisco, fifty resolute explorers were energetically and enthusiastically at work in various sections of the country through which the line was to pass, navigating turbulent rivers, forcing their way through virgin forests, traveling across snowfields and glaciers, climbing mountain ranges, conquering Matterhorn summits without guide or companion; leading "strenuous lives" in truth, without the stimulating concomitants of snap-shot photographers and daily newspapers to publish their exploits to the world. The surveying parties were usually composed of one American leader with one or two native guides, and sometimes with an additional white man. The journeys undertaken by them ran into thousands of miles and through the greatest difficulties. Everywhere they were met with the positive assertion of persons best acquainted with the country to be traversed that the proposed undertaking was impossible, but they had set out to do impossible things, and they succeeded. In scores of instances when native guides became lost and were wholly unable to find their way, the intrepid explorers, facing death by starvation or freezing, with a pocket compass in one hand and a Colt's revolver in the other, led their parties and pushed onward, and never failed to reach their destination.

After Kennan's trying sea-trip he was prepared to meet greater trials and hardships in Kamchatka, which he had pictured as a land of frozen horrors, and was astonished and fascinated to find himself in a Garden of Eden. In company with one American and two natives he traversed the entire length of the peninsula. For the first week of the journey they rode on horseback through a warm, fertile valley, rich with luxuriant verdure, beautiful, fragrant flowers, wild fruits, singing birds and all delightsome things. For many days they sailed in a houseboat constructed of three dugouts lashed together and covered with a platform on which a tent was pitched and a couch of fragrant hay and soft bearskins was spread. Down the peacefully flowing stream, margined by green, grassy meadows and wooded hills, and backed by distant, towering mountain peaks, robed in eternal snow and wreathed in white volcanic smoke, they floated and dreamed, told stories and sang songs of their native lands and absorbed strength for harder travel ahead of them, which came soon enough. For other days they climbed forbidding hills through narrow, rocky ravines, where their main diversion was found in pulling their horses out of streams after tumbles down precipices fifty feet high. Driven out of the mountains by a terrible storm of wind and snow in which they were lost, they followed the compass to the sea and, along a narrow beach, they ran a wild race of thirty miles with the incoming tide, while death followed close behind them. They won the race by five minutes and then hurried forward for another day and night without food or fire. And this experience was only a mild prologue to the tragedies of the year. At the end of this Kamchatkan trip of one thousand miles in three months Kennan spent a few days in collecting supplies and then started on another thousand-mile journey, in the dead of winter, from Ghijiga to Anadyrsk. Upon reaching the place he heard vague rumors, that had come through native sources, of a wonderful discovery described as smoke pouring out of a snowdrift through a sheet-iron stovepipe. Concluding that this must be the winter quarters of the men landed in Anadyr bay, and fearing that they might be in distress and danger, he immediately set out to find and rescue them. Three hundred miles of blank, snowy waste lay between him and the winter hut, and its locality was unknown. With three companions he traveled through terrible storms in temperatures falling to fifty degrees below zero. For the last fifty miles they were without fuel and were obliged to travel continually to escape certain death from freezing. Over and over again the men fell from exhaustion but, providentially, there was always one of the number able to hold out to aid the weaker men and keep them moving. Just when failure and death seemed inevitable the stovepipe was discovered. In the hut five men were whiling away the dreary days, fortunately, with a good food supply, an American cooking-stove and

ground pine, gathered in the summer, for fuel. Three days were given to hasty preparations for the return journey, the camp was then abandoned, and all returned to Ghijiga in safety. In the second winter Kennan made another journey to Anadyrsk and back with six cossacks, none of whom could understand a word of English. From Ghijiga he proceeded to Ohkotsk, and upon the termination of his telegraphic service, having traveled seven thousand miles in his journeyings and wanderings in the arctic regions, he took a pleasure trip to Moscow, which occupied ten weeks of steady day and night travel by dog sledges.

Bush, in his territory, was constantly engaged in equally daring and hazardous exploits. He sailed around Sakhalin island, landed at the head of the gulf of Tartary and proceeded down the Amoor river to the point near its mouth, from which the telegraph line was to start on its long way to Behring sea. Thence into the land of the Tungusians, riding on the backs of reindeer, his party threaded forests and swamps, crossed range after range of icy mountains, and reached the highest point in eastern Siberia, where the waters flow southward into the Ohkotsk sea, and northward into the Lena river and the Arctic ocean. Determined to get a view from one of the highest peaks, and unable to induce any of his fellow travelers to accompany him, he made the attempt to scale the heights alone, and succeeded. He climbed steep precipices of smooth ice, cutting steps with his pocket knife, clinging to jutting points of rock, crawling around corners projecting over fathomless chasms, and gained the summit where, for half an hour, he looked over a world of snow-white plains and slopes, dark forests sweeping away to the horizon, great rivers running in every direction, and mountain peaks by hundreds, uncounted, towering to the skies. Deeply impressed by the awful grandeur and solemnity of the scene, he still held to the one purpose of the expedition and, out of many possible routes by which the telegraph could be built through the desolate land, selected the best. He continued his journey to Ohkotsk and thence to Ghijiga, a distance of twenty-four hundred miles. The following season he went over the route to the mouth of the Anadyr river and Behring sea. In one respect his experience with reindeer travel was peculiar. There were many wide rivers to cross and, as the reindeer could not stand on the ice, it became necessary to slide them down the banks, from twenty to one hundred feet high and haul them across the river and up the opposite banks. One of the most surprising incidents noted by Bush occurred when, upon entering the camp of the most barbarious Siberian natives, he heard a chorus of boys singing "John Brown's Body Lies Mouldering in the Ground." He was still more astonished to meet, in one of the most smoky and filthy tents, a beautiful blonde girl, dressed in tasteful fur garments and with a clean face. During their winter of isolation on Anadyr bay, MacRae and his men thoroughly surveyed all the territory roundabout Behring sea. Through the entire Siberian campaign Major Abasa, imbued with a spirit of autocratic military domination, and with the combined intrepidity and dash of Russian cossack and American cowboy, was always on the move, stopping for no personal hardship, directing, encouraging, and urging haste at all times. He visited every part of the route and accompanied his assistants on many of their hardest trips. The selection of routes was closely followed by the actual work of construction. With the aid of native workmen large quantities of poles were cut and distributed along the line, while the wire and other material were collected at the most convenient seaports. At the outset some of the native tribes understood that the poles were to be set close together along the routes marked out and, fearing that this would circumscribe the free travel of their herds of reindeer, were violently opposed to the telegraph. When they were made to realize that the largest herds could pass between the poles their opposition ceased. In one camp of workmen, who were instructed to cut poles six inches in diameter, a long discussion regarding the strange innovation was held with the conclusion that it was to be some sort of an elevated road and that such small poles would not support it. At the end of the season they had delivered an immense number of logs, five times the size given in the specifications.

In Alaska and British Columbia the work of telegraph exploration and construction was promptly commenced and vigorously prosecuted. Kennicutt and his associates, among whom were Dall, Ketchum, Ennis and Whymper, explored the entire valley of the Yukon and many of its tributaries, then an unknown land. It had been a disputed question whether the Yukon emptied into the Pacific or the Arctic ocean, and the location of this stream along its entire course by Kennicutt's party proved of immense value. Numerous trips up and down the river, both in summer and winter, were made by members of the expedition. They ascended the stream, laboriously paddling their boats or walking along the banks, pulling them over rapids and carrying them around waterfalls. Forty days were spent on these upward journeys, while the return trips were accomplished in four days of rapid, reckless travel, rushing down with the swift currents, through dashing, surging rapids and shooting over waterfalls. Ketchum and Labarge made a memorable journey of six hundred miles from the mouth of the Yukon to Fort Selkirk, starting out against the protestations of their associates, with only three days' provisions, penetrated a section of country never before visited by white men, obtained valuable information and returned in an incredibly short time. The country from St. Michaels to Behring sea was surveyed and a point selected for the connection between the land line and the submarine cable. The Alaska men even went outside of their own territory and surprised the camp on Anadyr bay by neighborly visits.

The immense stretch of wild territory between the Yukon and the Frazer rivers, embracing a thousand miles of virgin forest, many lakes from ten to one hundred miles in length, mountain ranges and river valleys, was tramped over and carefully examined by Major Pope and his men. They started at Quesnel, on the Frazer river, followed up that stream for a considerable distance and then struck into the woods to the northwest. They chopped a way through tangled underbrush and fallen logs, forded and bridged rivers, climbed mountains, camped in solitudes far from civilization, supplemented their store of scanty rations by fishing and hunting and found never-ending delight in the romantic witchery of the wildwood. At the northern end of lake Tatla they built a substantial log house for winter quarters and for a permanent telegraph office and remained there two months waiting for the snow to become consolidated and fit for travel. The early training of these hardy boys from the Berkshire hills fitted them to withstand a temperature of fifty-five degrees below zero and their letters home were filled with glowing accounts of good times. On the days of extreme cold the forests resounded with apparent volleys of musketry, which were caused by the bursting of big trees.

In the month of January, 1866, Pope

secured four dogs, made harnesses for them and selected one white man and two Indians as companions for a three months' journey. The courage of the Indian guide who had agreed to accompany the party failed at the critical moment and Pope, "trusting in Divine Providence and the magnetic needle," set out to find a way to the Stikine river and meet Kennicutt's men on the Yukon. With snowshoes on his feet and a thirty-five-pound pack on his back he took the lead, breaking a trail through five feet of snow, while the dogs floundered after with their heads barely visible above the drifts. When the dogs became too tired to pull the sleds the men helped them; when dogs gave out entirely the men carried them and pulled the sleds themselves. They were often compelled to make stops of a few days to let the dogs recuperate. Such occasions were improved by Pope in climbing neighboring mountains searching for the stream that led to his destination. He discovered the sources of rivers flowing southward into the Frazer, westward into the Pacific and northward into the Mackenzie and the Arctic ocean. Down the Stikine river the party proceeded, traveling along its icy bed and over its rocky banks; into a deep, weird cañon, with walls hundreds of feet in height; along a narrow shelf of ice with a furious torrent on one hand and a bare wall on the other, and dangers at every point. Up precipitous ledges three hundred feet high, and over a forty-mile portage, the men carried supplies, baggage, sledge and dogs, working sixteen hours every day, making all possible haste to reach the end of the journey before the snow became too soft for travel and their food supply become exhausted. The "impossible" was accomplished and success crowned their efforts.

At the close of the year's work Pope, who was the most experienced and competent telegraph engineer in the whole expedition, expressed the opinion that the entire line, from the Frazer to the Amoor, could be completed by the fall of 1867, and reports from other departments confirmed that opinion. To reach that end the energy of every man was put forth. To them, in their isolation, tidings from the world seldom came and they were in ignorance of the progress of events. The Atlantic cable had been in operation many months before the news reached them and orders to abandon the overland enterprise were received. They were sadly disappointed, and reluctantly obeyed instructions to return to their homes.

Along in the years '66, '67 a strange spell fell on all that Russian domain, the result of vague reports, passed from tribe to tribe, that some great change was impending. What that change was to be the people did not comprehend, but all hopefully awaited its coming. When they realized that the imperial flag was to come down and be replaced by the Stars and Stripes, joy was universally felt on the American side of Behring straits and disappointment filled the land of their neighbors that they too had not been included in the transfer.

Thirty-five years later, when the people of the United States desired to run a line of telegraph to the northwestern tip of the continent, they said "by your leave" to nobody. The entire route lay within their own domain. In less than three years the officers and men of the army signal service, under the direction of General A. W. Greely, laid more than two thousand miles of submarine cable, connecting Seattle with Valdez; built more than fifteen hundred miles of land line between Valdez and St. Michaels, and spanned Norton sound by means of wireless telegraphy. The records of the experiences of the Russian-American explorers, in 1866, and of the officers of the signal corps, in 1903, tell stories of indomitable spirit, personal heroism, severe labor and hardships, and splendid achievements that are identical. The successes of the former were the result of individual interest and enthusiasm, harmonized and concentrated in one grand endeavor; the accomplishments of the latter were attained under a régime of "military solidarity," which relentlessly forces men, willing or unwilling, to obey orders and go forward. In one respect the work of the army has been more important than that of the pioneers. General Greely's men constructed, completed, and are maintaining, in actual service, nearly four thousand miles of line. The poles are standing and the wires are humming along a route that leads across perpetually snowbound Arctic wastes, through vast forests, over mountain ranges ten thousand feet high, seamed with glaciers and encased in ice, and along rivers where summer floods sweep everything away. The routes selected in 1866 have been followed to a considerable extent by the lines built since that time in Alaska and British Columbia, and the work of the early period has been of much advantage to the later enterprises. No country more difficult for telegraphs exists anywhere. In executing the work the officers and men of the army, laboring summer and winter, often met emergencies that called for decided action quite as urgent as though they were facing the enemy in time of war. They traversed the country from end to end, making journeys of great length in the dead of winter and under most trying circumstances. One of the officers made a three-day trip over a bleak, icy mountain, with a steady temperature of sixty-eight degrees below zero and the wind blowing fifty miles an hour. During this journey he was obliged to assist the dog team in hauling the sled over hard places and keep his only companion from freezing to death by constant aid and encouragement. For pluck and endurance the young officers far excelled the toughest Indians. When the West Pointers went to Alaska they packed away their uniforms and insigina of rank, put on heavy Arctic clothing and enveloped themselves in blue denim kimonas with fur-lined hoods. This garment, a modification of the Russian "parka," has proven the best protection against cold winds and is one of the necessary adjuncts of Arctic travel.

Upon completion of the work a line of vigilant army pickets was stationed, forty miles apart, to stand guard over the frail thread of wire, exposed to danger from fire and flood, storm and tempest. Day and night they watch and listen to the heartbeats of humanity pulsating round the world, and upon the slightest sign of danger they take prompt measures to protect their charge. Three men and four dogs comprise the force at each station. In case of interruption to the line two men set out together to repair the break. In winter they travel with a dog-sled, carrying wire, tools, provisions, a tiny cook-stove and a light tent, never forgetting to take that most necessary of all implements, an axe, with which to cut firewood and ice, and, on occasions, to chop off their frozen foot-gear. When they are compelled to stay out over night or are caught in a storm, they pitch their tent, set up housekeeping and wait for morning or clear weather.

The manufacture, transportation and laying of the Alaskan cables was an undertaking of great magnitude which was performed with despatch and marked success. In 1865 ocean cables could not be made in the United States. The cable intended for crossing Behring sea was procured in England and shipped round Cape Horn. When cables were needed in 1903, American enterprise proved equal to the occasion and was prepared to supply the

world. The requisite quantity was manufactured in New York and shipped on special trains across the continent, where a government vessel awaited it. The ship, heavily laden, sailed over a stormy sea, whose bottom was little known, against sweeping tides and currents and along dangerous coasts, paying out the line that avoided the route through British territory and placed the entire line under the American flag. Two weeks after the last section was submerged an inquisitive forty-foot whale, jealous of intruders into his domain, ate the insulation from twenty feet of the wire and was electrocuted. The same week the cableship Burnside ran on a rock and received injuries that took two months to repair. Ten days after she was again in serviceable condition, the cable and the dead whale were hauled up and the line put in working order.

The pioneers ran their telegraph lines through many places that have since become famous as gold-producing localities, and in digging holes for the poles often threw up earth rich in the precious metal. The laborers picked up a few of the biggest nuggets and then rammed the auriferous earth around the poles to hold them firmly in place and enable them to withstand the winter gales and summer floods. They were building a telegraph line, not prospecting for mines. Neither dangers, hardships nor opportunities for personal profit swerved them from the one clear purpose of the undertaking. Two years ago a private soldier of the United States army, while driving a finely tempered steel bar into the frozen earth, struck something no harder, but of a different texture, which appeared to show indications of gold. He filled his pockets with fragments of the rock, marked the pole with strange hieroglyphics and at the first opportunity sent his specimens to an assay office. The result proved them to be richer in gold than ore from many of the most profitable mines in the country. The telegraph pole that stakes out the soldier's claim stands in a section of the line forty miles long, with thirty poles to the mile, and the soldier is the only person in the world who can find it. His term of enlistment will expire in six months.

On Christmas day, 1902, a solitary, famished individual came into a government telegraph camp in the Tanana valley seeking food, of which he was in great need. Just before leaving he had a moment's whispered conversation with one of the men who had shared rations with him. His secret passed from one to another, and within twenty-four hours every civilian in the party was madly racing over the desolate hills, without provisions, tools or means of shelter, to the new gold-fields discovered by the starving prospector, which were on the site of the present flourishing city of Fairbanks.

Away out near the farthest point on the American side of Behring sea a line of telegraph poles, erected in 1866, is still standing, sound and strong. Their permanency is due, as explained by a recent scientific visitor to that locality, to the fact "that they are not subject to the ravages of tropical insects." Overlooking that spot stands a high, conspicuous, wireless-telegraph tower erected by General Greely in 1904. For thirty-eight years the old line has remained dumb. From the new tower electric signals flash and pulsate a thousand miles out to sea, calling to ships whose masts are tipped with the new St. Elmo's fire, and far across Siberian wastes, studded with mountain peaks, bearing a message from the new liberty-loving world to the liberty-longing millions of ancient empires. The world awaits the answer.

Electrical Progress in Britain.

By W. A. Chater.

IN ONE department of Britain's industrial life the Prince of Wales's warning trumpet call "Wake up, England !" after his tour around the world did not fall on idle ears. The electricians of the old country have been keenly alive to the possibilities of the new agency with which human power has invested itself at the dawn of a fresh century. Electrical development in England, retarded twenty years ago by initial obstacles raised by Parliament through the conservative spirit inherent in the national character, has in the last three or four made rapid strides. The native engineering profession may with reason congratulate itself that ground lost at the beginning of the era of electricity has been to a large extent recovered. To-day England on her own soil in the invention and installation of electrical apparatus under every form is keeping pace with her rivals, America and Germany. But recent progress has been so rapid that the full extent of the advance made has, as yet, been hardly realized.

In England, electricity, apart from telegraphy, became familiar to the public first as an illuminant. Its use as a motive power in traction followed slowly. The telephone is still making its way into universal favor. For the thousand and one adaptations to household purposes the advantages to be derived from its employment as a maid of all work have yet to be appreciated. But in the main direction the practical British genius has seized on the new agency with promptness and avidity. One can not take a tour through Great Britain in a visit, especially to the great industrial shipping and manufacturing centres of the northern counties, without being struck by the evidence of the intense energy now being thrown into electrical development.

The supply of electricity in bulk is the dominant factor.

Owing to the concentration of great masses of population in the cities and manufacturing districts and the proximity of coal fields and other natural resources it is recognized by leaders of industry that in the race for the world's commerce Britain already possesses advantages which may offset those points in which she is handicapped in competition with her rivals.

ELECTRICITY SUPPLY AREAS.

The idea of establishing in various parts of the country centres of electric power supply wherever the industrial population is already located has taken firm hold of Parliament, capitalists and power users. England and Scotland have been mapped out into large areas, which private companies have marked out for their special spheres of operation for the supply of electric power. The first power bill of this kind was only promoted in 1899, and embraced a large area in the centre of England. But a number of schemes have now been sanctioned by Parliament covering nearly all the industrial areas of the kingdom. Between twenty and thirty of these companies have now begun actual operations, and the past twelve-month has seen the opening of great generating stations, erected by several of the younger companies. The total capital of the companies authorized by Parliament amounts to nearly $150,000,000. Only the financial depression of the last two or three years

has prevented the rapid execution of the schemes for which actual authority has been obtained.

In the next session of Parliament, from February to August, the applications for private bills relating to electricity number 156. This number includes thirty-two of the larger schemes for electric lighting and power supply. There are ten bills for electric railways and twenty-four electric tramway bills. The most important bills to be dealt with by the special Parliamentary committees will be those relating to the supply of electricity in bulk to the metropolis, London, where the interests at stake are of gigantic magnitude, municipally and financially.

The companies already in the field distributing electrical energy in bulk over their respective areas are the following, as shown in the accompanying map:

England—North Eastern District—Newcastle-on-Tyne Electric Supply Company, Durham County Electric Power Company, Cleveland & Durham.

Northern—Lancashire Electric Power Company, Yorkshire Electric Power Company (Leeds), Northwestern Electricity Power Company, Derbyshire & Nottinghamshire Power Company.

Midland—Shropshire & Worcestershire Electric Power Company (Birmingham), Leicestershire & Warwickshire Electric Power Company, Gloucestershire Electric Power Company (Bristol).

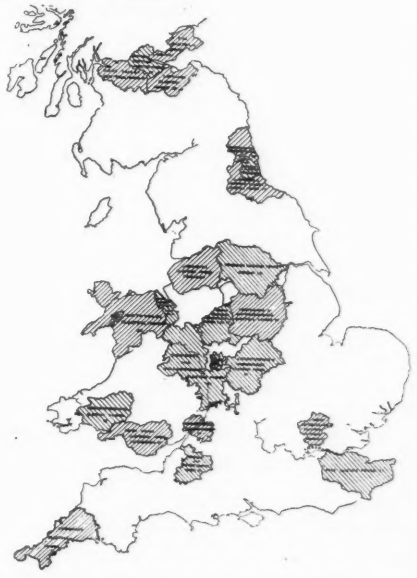
London—North Metropolitan Electric Power Supply Company, Kent Electric Power Company.

Wales—North Wales Electric Power Company, South Wales Electrical Power Distribution Company (Cardiff), Carmarthenshire Electric Power Company.

South—Cornwall Electric Power Company, Somerset & District Electric Power Company.

Scotland—Clyde Valley Electrical Power Company (Glasgow), Scotland Central Electric Power Company, Fife Electrical Power Company, Lothian Electric Power Supply Company, Newcastle Company (the pioneer).

Of these power companies the Newcastle-upon-Tyne Electric Supply Company is regarded as the pioneer company of the country, and the history of its development during the fifteen years of its existence taken in conjunction with its consistent career of commercial success entitles it to first consideration in any survey of recent electrical progress in England. The company started in 1889 as merely an electric lighting business concern in a comparatively small area, but its directors included men connected with some of the most important industrial firms in the North of England and from a small company dealing with a single city it has, step by step, embraced the whole area of Tyneside and the neighboring county of Durham. It is now authorized by Parliament or by agreement to supply electric power for all purposes over a district of 625 square miles. It probably supplies a greater variety of customers than any other system, as, besides its original lighting of streets and houses, it generates electricity for the Tyneside tramways, the North-eastern Railway's local electric lines, warehouses and workshops, and almost every form of factory in addition to supplying other local authorities in bulk, several municipalities possessing their own parliamentary privileges finding it more convenient and economical to use the current afforded by the Newcastle company's mains.



ELECTRICAL UNDERTAKINGS IN GREAT BRITAIN.

It has an output of 50,000 horse-power and is increasing that amount to meet the growing demand for its supply, whether for traction, factory power, lighting or bulk supply to minor companies and authorities. Its three chief generating stations are at Pandon Dene, Neptune Bank and Carville with seven substations. The Neptune Bank station, built in 1899, was designed to supply three-phase current at a pressure of 5,500 volts and a periodicity of forty cycles to replace the single-phase system operated in the original Pandon Dene station. But in its turn the Neptune Bank station has been quickly superseded as the company's main productive station by the building of the Carville power-house, whence the energy is now chiefly derived for the supply of electricity to the Northeastern Railway Company and the adjacent shipyards on the Tyne. Two main cables are being laid into the Durham district of a length of eighty miles.

THE CARVILLE POWER STATION.

The Carville station was opened in 1904. It was designed by a young engineer, Mr Charles H. Merz, with special attention to the desiderate of security of supply combined with low capital cost. It is admirably fulfilling its purpose and has been taken as a model in the construction of many power-houses all over the United Kingdom. The leading features were: (1) the use of steam turbines; (2) the adoption of "the complete unit" system under which the station plant is divided into a number of complete sections operated independently; (3) the use of water-tube boilers of the marine type; (4) the use of automatic oil-break switchgear of the cellular type worked by electricity. In many respects the introduction of many details of the equipment was novel and experimental, requiring initiative courage on the part of the designer. After much consideration it was decided to adopt steam turbines of the largest size then obtainable as the result of favorable experience gained from 3,000-horse-power turbines in use during the two years previously at Neptune Bank. The present equipment at Carville consists of two 3,000-horse-power turbo-alternators and two 7,000-horse-power turbo-alternators, at the time of installation the largest turbines in use for electrical purposes. So well have they demonstrated their economy in steam and cost of maintenance that the general adoption of the steam turbine on land has been much more rapid than the introduction of the same type for marine purposes. The turbines used by the Newcastle company are those manufactured by C. A. Parsons & Company at their Tyneside works, and tests show that with steam at 200 pounds superheat 150 degrees Fahrenheit the steam consumption of the large turbo-alternators does not exceed eleven pounds per brake horse-power-hour at the most economical load, a figure comparable with that of the best steam engines. Each boiler house contains ten water-tube boilers of the Babcock marine type in two separate banks of five, each bank being sufficient to supply one of the large sets with one spare. Under the guidance of the company's general manager, Mr. Joseph S. Watson, I was shown how economically the coal was handled. Each boiler house has a separate bunker into which the coal is discharged from an overhead siding, onto

which the trucks are drawn by an electric locomotive. Independent shoots deliver the coal through weighing-machines to the automatic electrically driven chain-grate stokers in front of the boilers. The ashes are removed by means of a conveyer discharging into trucks so that both coal and ashes are handled mechanically throughout. The resident analytic chemist makes frequent periodic examination of the cinder, refuse, and any deviation from the required standard of combustion is quickly noted for explanation at headquarters.

THE SWITCHBOARD GALLERIES.

The type of switch-gear employed was somewhat new in England at its installation, the increased power to be handled necessitating a totally different form of switch from that formerly employed, a main switch in a station like Carville having possibly on occasion to break a circuit carrying 20,000 horse-power or more. The switchboard was made equal to the engine room with four galleries, the two top galleries each containing a set of "bus-bars"; the main switches are on the next, the ground floor being occupied with instrument transformers. The main switches "break" and "make" in oil, but there is an auxiliary contact in air and each switch is operated by a small motor, the operator having nothing to do with the high-tension connections at all. Automatic protective devices are supplied for isolating excessive overloads, and a complete service of compressed-air-pipes is installed for cleaning.

Passing from the Carville works into the shipyard of Swan, Hunter and Wyham Richardson I was enabled to see how the electric current supplied by the Newcastle Electric Supply Company was being utilized in the rolling-sheds, in electric hammers, cranes, lights and by the workmen engaged on the hull, nearly completed, of one of the giant twin Cunard "flyers" on the stocks within a giant covered shed.

A few days later I contrasted the progress of this vessel with that of its sister, building on the bank of the rival river, the Clyde. Adjacent to the shipyard of Messrs. John Brown & Company, the constructors, are the works of the Clyde Valley Electrical Power Company, which has alloted to it an area containing the most important manufacturing and coal-producing district in Scotland, but which, starting later than the Newcastle company, is still in its initial stage. The company has two generating stations, one at Yoker and the other at Motherwell, erected and equipped by the British Westinghouse Electric and Manufacturing Company. The Yoker station was formally opened in June, 1905, and the main generating plant at present installed consists of two Westinghouse-Parsons steam turbines, each with a normal capacity of 3,000 horse-power and an overload capacity of 3,750 horse-power. Each turbine is directly connected to a Westinghouse 3,000-horse-power generator, giving current at a pressure of 11,000 volts, three-phase, at which pressure the current is distributed to the substations. The total capacity of the station when completed will be 13,000 horse-power.

ELECTRIFYING COTTON MILLS.

Another date of the past year memorable in British electrical annals was October 10, for it marked in Lancashire the dawn of a new era in its industrial area. To compete with the ever-increasing manufacturing ability of other nations it is of vital importance to Lancashire cotton manufacturers to cheapen production. The supply of the necessary electrical energy to do the work of innumerable steam engines it is expected will enable the British cotton manufacturers to drive their spindles with such a decided improvement in economy that enjoying other advantages they will be able to keep ahead in the world race for existence. The opening of the electric power generating station at Radcliffe by the Lancashire Electric Power Company, an enterprise inaugurated by the Earl of Derby and Sir Lees Knowles, M. P., Liverpool and Manchester magnates, completed the first step in this development. It has been speedily followed by the opening of the Acme Spinning Mill, Pendleton, with 75,000 spindles, the first electrically equipped and chimneyless spinning mill built in England. It is supplied with current by the Lancashire Power company, which is most favorably situated for supplying power within a circuit crowded with cotton mills and engineering workshops. The Radcliffe power station is placed on the left bank of the river Irwell, on the brink of a colliery. Abundant condensing water and coal supply is thus assured and the Lancashire & Yorkshire Railway runs by the station. The plant consists of four Curtis turbo-generators made by the British Thomson-Houston Company, each of 2,000 kilowatts, running at 1,000 revolutions per minute, generating three-phase current at 10,000 volts and fifty cycles. The station is laid out on the unit principle, each unit workable quite independently of the other, and extension will be easy. The whole arrangement is so simple that a shift of six or seven men can look after the entire plant of 10,000 horse-power.

In Wales electricity in bulk is being supplied in a similar way to the country's mines and quarries. The South Wales Power Distributing Company opened a new feeder line in September for surface and underground haulage and pumping work at the well-known Cambrian collieries and Ferndale collieries. Messrs. D. Davis & Sons are laying down plant of 1,850 horse-power, and other collieries are either increasing existing or installing new plant. So far the use of electric power in the South Wales coal mines has been free from any serious accident or inconvenience and in a recent serious explosion not a wire was broken. The company has two generating stations near Pontypridd, Monmouthshire, and two smaller stations at Bridgend and Neath to supply an area of 2,000 square miles. Next year it will provide an output of about 25,000,000 units for collieries and the local steel, tin plate, wire and brick-works, and for foundry, quarry and chaff-cutting purposes. There are many instances to be found in the country, it is worthy of notice, where enterprising farmers are using the local supply of electricity for threshing, chaff-cutting and barn operations, gaining economy in many of the smallest details of farm work. In connection with the North Wales scheme for supplying electric power to the great slate districts and other quarries and railways, Lake Llydaw, part of the old crater of Snowdon, has been harnessed to furnish motor power for generating electricity, a tunnel having been bored to a depth of thirty feet at the bottom of the lake.

MUNICIPAL MONOPOLIES.

The companies I have described are private undertakings. As authorized by Parliament to supply electricity over large areas, they enjoy special privileges, the franchise in most instances being of a perpetual character, and their powers are entirely different from 300 private and municipal undertakings created for the supply of energy for lighting and traction and to a small degree general power. They, however, come into competition with the more ambitious municipalities governing the great cities. Manchester, Glasgow and other towns are unwilling to tolerate any rivalry within the administrative areas of their civic councils, and they too have grasped the significance of the introduction of high-tension cables as the possibilities of cheapening the cost of power by the economy of the production and the importance of the load and diver-

sity factors have come to be realized. The electric lighting act of 1882 put back the electrical industry of Great Britain fully six years until the amending act of 1888 was passed. The risks of danger from overhead wires were overestimated, and though overhead wires have been proved fully as safe as underground mains in the English climate, obstacles were raised against overhead systems. As the cost of underground as compared with overhead transmission will be power for power as nine is to four, this acted as a bar to progress and rapid extension. There was also in the original act an onerous purchase clause which similarly acted as a deterrent. When these barriers were removed or mitigated the local municipal and other authorities were quick to assume either actually or provisionally powers for traction as well as lighting. There is now no great centre of population and no second or third-rate town without a public supply of electricity. Some cities have obtained parliamentary powers giving them a complete monopoly of the supply of electricity for all purposes. Municipalities were at first favored, but owing to the outcry of overtaxation, the increase of rates and more expensive management of municipal industries, municipalities have found an increasing difficulty in obtaining loans to carry out their projects, and private corporations of capital have found a more willing disposition on the part of Parliament to allow them to work side by side with municipalities and in some cases to give them the preference where it can be shown that they are able to give the public a better service than that provided by the municipalities acting as their own electricity purveyors.

As regards the metropolis, London, this question of the supply of electricity by the municipality or by private companies is a burning one and after an indecisive battle last session in Parliament has again to be fought out this year in the legislature. Manchester and Glasgow, on the other hand, may be taken as the typical instances where municipal monopoly reigns.

MANCHESTER'S GENERATING STATIONS.

I was privileged to view the generating stations at Manchester, the second city of England and chief distributing centre of commerce in the north of England. The city has within its supply area of twenty miles a population of about 700,000. Outside the city boundaries proper adjacent small local authorities have found it to their advantage and convenience to transfer their lighting power to the Manchester corporation, having first gained the necessary consent of the government Board of Trade. Manchester has two main generation stations. The Dickinson street and Bloom street joint stations are in the heart of the city, a small river flowing between them capable of barges bringing material to them. The station supplies low-tension direct current. At the newer station, Stuart street, which has an area of 40,333 square yards, as against the 7,434 square yards of the older station, the supply is high-tension alternating current transformed at distributing stations. The charts shown me by the resident engineer proved satisfactorily how, by careful tests and economical working, the cost per unit was less for the corresponding month of the previous year during the last three years. The consumption of coal per unit of electricity generated is three pounds, the price being of an average of $1.75 and $2 a ton. Turbines here also have been introduced with very satisfactory results, the absence of vibration conducing to less expense through wear and tear and less complaint from neighboring property owners. Several ingenious contrivances have been put into operation by the engineers of the station. One feature, that of sparkless commutation at a high peripheral speed thought impossible until executed here, was specially noteworthy, as was the binding of an armature with piano wire to prevent the conductors from flying out. In the year ending last March 31 the total of units generated was 47,170,721. The load-factor was 26.89 per cent and the total generation costs, exclusive of special renewals, was 0.72 cent. The capital expenditure since the beginning of the undertaking in 1894 has been $10,998,447, making $435 per kilowatt capacity of plant installed. The total maximum supply demanded last year was for lighting and power 12,779 kilowatts, and for traction 7,244 kilowatts, = 20,023, and a large increase is expected this year. The normal capacity of the plant is 25,300 kilowatts, and the total length of main conductors laid is 292 miles, 165 yards; equalling 650 miles, 1,529 yards of single cable. The original fixed charge for consumers for lighting was eleven cents per unit; this has been reduced to nine cents.

Glasgow, which is conducting municipal enterprises on a more comprehensive scale than any other city of the United Kingdom, is unlike Manchester in that it keeps its lighting and power supply electrical department district from its traction system, which is a separate undertaking. It has a total horse-power available from its three generating stations of about 27,250 and expects that the increasing demand will necessitate new plant for a further 10,000 horse-power before another winter. The increasing revenue is largely due to the growing sale of current for power supplied to all classes of trades in Glasgow and the department has been able to make substantial reductions in its charges. For power and heating purposes, the Glasgow charge is now three cents per unit for 1,000 hours and half that amount per unit for extra consumption and for lighting seven cents per Board of Trade unit. Last year the quantity of electricity sold to private consumers showed an increase of 22.36 per cent over the previous and the total number of units consumed for power purposes was 4,706,029. The result of the increased revenue and relative reduction of costs was that the balance on the year's ordinary working was $304,965.

LONDON'S LEEWAY.

In the general use of electricity London is a long way behind many of England's provincial towns. Yet there is no place where the need is more pressing for an economical supply of motive power. London has over 30,000 factories and workshops employing half a million workers and the total horse-power installed is more than 600,000. But the present electricity supply authorities supply only the small proportion of some 40,000 horse-power.

The poor showing made by the world's largest city at present may be seen from the following table:

Name of City.	Population.	Horse-power Connected per 1,000 Head of Population. All Purposes.	Power Only.
Boston	541,700	123	52
Tyneside	377,047	115	49
New York	2,525,000	73	35
Frankfurt	306,000	80	29
Berlin	2,285,000	82	22
Hamburg	760,000	77	13
London ("industrial area")	3,723,770	26	4

With this ample unoccupied field as a prize to be won it is no wonder that eight companies promoted bills which were considered exhaustively by Parliament last session. Two succeeded in obtaining acts, the Metropolitan Electric Supply Company, which was granted the western portion, and the North-Metropolitan Power Company. A third bill, that of the Administrative company, to which was given the eastern and southern portions, mainly the industrial sections of London, particularly along the Thames banks, came within an ace of being passed. At the winding-up of the session, however, owing to pressure brought upon the government by its opponents it suffered the fate of

legislative innocents and was dropped, the outlay incurred in its promotion and Parliamentary committee charges amounting to $175,000 being practically lost. In the coming session it is to be revived. One notice has been given of nine electric power bills concerning London, but the real fight will probably be found to rest between the Administrative company, which is a private company originating from the successful pioneer company of Tyneside, and the London county council representing the municipal trading principle. The proposal of the Administrative company briefly is to erect three immense generating stations equipped with turbines larger than any hitherto built and each with a capacity of 90,000 kilowatts. The undertakers have taken as a model for their tenure of the privileges they seek the franchise of the Interborough Subway Company, of New York. The maximum prices to be charged are to be from three cents to one and three-quarters cents per unit. At present the average price of electric current in London is six and one-half cents per unit.

FIRST RAILWAYS ELECTRIFIED.

Side by side with the solution of the problem of an adequate supply of electric power in bulk the answer to the questions involved in the proposed electrification of existing railways is being worked out in England, as in the United States, with quickening pace. For the whole country the north is again in the forefront, where the Lancashire & Yorkshire and the Northeastern Railway are reaping the reward of the enterprise of their managers in the established success of portions of their ordinary steam traction lines which were electrified. Both systems have been working electric lines since March, 1904. The Northeastern Railway has a route of thirty-five miles in the Tyneside district worked by current supplied by the Newcastle-upon-Tyne Electric Supply Company. It has regained traffic lost by competing street electric tramways and is proceeding in consequence to electrify other branch lines of its area. The Lancashire & Yorkshire's Southport electric line from Liverpool, thirty miles long, has become a popular institution. It is the only electric railway running coaches sixty feet long by ten feet wide and carrying out an express service running eighteen miles without a stop at sixty miles an hour with a train weighing 180 tons. It has been stated that the cost is 0.33 pence or 0.66 cent per unit. The company's chairman has attributed the traffic increase of 600,000 passengers in each half-year during its operation largely to the appreciation of the electric installation. Other trunk lines have schemes under consideration for electrification of local branches, this step being necessitated by falling off in passenger traffic during the last summer. The London & Northwestern has suffered severely at several of its great centres and so seriously has the Great Eastern Railway been affected in its suburban section of East London that its chairman, Lord Claud Hamilton, early took up the question of electrifying this part of his line, proposing an electric tunnel railway under the existing tracks from Liverpool street station in the city. Such formidable difficulties and costliness, however, were found to be in the way that the scheme remains in abeyance.

UNDERGROUND LINE TRANSFORMED BY MR. YERKES.

Nevertheless, London has during the past year made a signal achievement in the substitution of electricity for steam on her underground system consisting of the Metropolitan Railway and the Metropolitan District Railway, with a combined length of sixty-seven miles, with a third and fourth-rail system of current supply. The introduction of the electric working of these railways took place in January and July and the close of the year has seen the full accomplishment of the undertaking, though life was not spared to the American pioneer, Mr. C. F. Yerkes, to whose initiative, courage and tenacity the scheme of electrification and its execution have been preeminently due. The underground lines thus transformed are a surface brick or cut-and-cover tunnel, whereas the system of tube electric railways, a distinctive feature of London's solution of her traffic problem, lies at an average depth of sixty feet in the London clay beneath the surface. The cleanliness, comfort and rapid transit secured by these tube electric railways can best be appreciated by those who compare present conditions with those existing even two years ago. It is possible to cross London from north to south in half the former time.

Of the seven railways of this class already working or under construction, with a length route of forty miles, the City & South London Railway, opened in December, 1890, was the first in the metropolis. Its originator, Mr. Charles Grey Mott, and chairman of the company since its inception and opening by King Edward, then Prince of Wales, fifteen years ago, until his death a few weeks ago, is another of the railway pioneers who first grasped the results of the initial experimental electric railways in 1881 at Portrush, in Ireland, and Lichterfelde, in Germany. For the four tube London railways already working the total horsepower available is 18,500. The turbine engines of the Chelsea power station, belonging to the Underground Electric Railways Company, furnish the Yerkes Metropolitan railway with 80,000 horsepower. In the course of the next year or two the lines under construction, their extensions and other lines falling within the general scheme of London's railway transit, must inevitably effect an immense change in the city's passenger traffic conditions.

ENGINEER'S TRAINING.

While in a cursory survey of the electrical field in Britain the rise of the power supply companies must claim the lion's share of attention, the parallel extension of street electric tramways, the universality of the electric lamp, the spread of the telephone and the adaptation of electricity to domestic uses in a myriad form can not escape the notice of any traveler in the country. In the latest built vessels for ocean traffic, as in the Cunard liners set running to America during the year, the comprehensive use of electricity from the Marconi installation to the electric toaster of the ship's kitchen is seen on the best concentrated scale. The control of the turbine-driven engines, steering gear and water-tight compartments from the captain's bridge demonstrates the increasing mastery attained by the engineer over the new motive power, while it comes into play in almost every department of the floating city's daily economy. A general electrical exhibition, held at the Olympia Hall, in the autumn, impressed one with the variety of electrical inventions for household purposes, medical and chemical uses and scientific research. On the theoretical side nowhere are there more encouraging prospects for the training of the future electrical engineer than in such engineering schools as that of the Birmingham University and King's College, London. But throughout the country wherever electricity is providing new industries there is abundant evidence in the output of electrical plant and apparatus of practical energy and vigorous life springing from a sound application of theory tested by experience.

"Municipal Electric Lighting in Brooklyn" is the subject of a pamphlet published by the Edison Electric Illuminating Company, of Brooklyn, containing interesting facts and figures bearing on the report of the Municipal Electric Lighting Commission of the Board of Estimate and Apportionment.

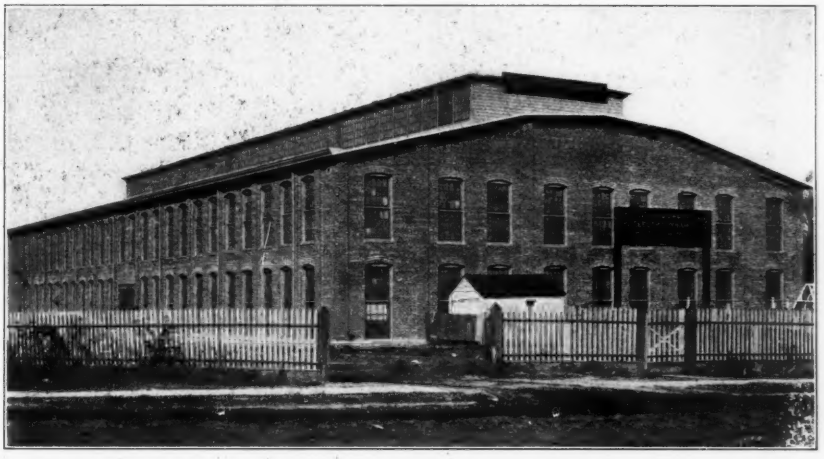
The Plant of the Electro-Dynamic Company, at Bayonne, N. J., and the "Inter-Pole" Variable-Speed Motor.

THE plant of the Electro-Dynamic Company is located at Bayonne, N. J., at a point where the Central Railroad of New Jersey crosses Newark bay. The large brick building, 100 feet by 221 feet, is adjacent to the plant of the Electric Launch Company. The main building is composed of a main bay and two galleries, and houses the equipment for the manufacture of motors and generators and the necessary special tools. The pattern shop, carpenter shop and crating department occupy part of a corrugated-iron building situated at some distance from the main plant. This building also accommodates the forge shop, where tool-dressing and light forge work are undertaken, and, in addition, serves as a storage house for oils, paints, varnishes and inflammable material. The pattern storage house is in another separate building. Because of the location of the plant rather extraordinary fire precautions are taken.

The plant is arranged for a systematic and easy distribution of stock. Just outside of the building is located the storage yard for rough castings, the stockroom for finished material and parts of construction, occupying a greater part of the southern side of the building on the left of the central entrance. Immediately to the right of the entrance on the southern side there is a small stockroom for insulated wire and insulating material. Just below this stockroom is the department for cleaning and dressing castings. Light erecting is done in the corner of the building below the department for cleaning and dressing castings, and this erecting department is carried across the extreme eastern end of the building and about halfway up through the central portion of the building. The heavy machine tools are arranged along either side of the erecting department to a point opposite the central doorway.

On the north side of the building are located the machines for punching the armature and field laminations, and in this department is also carried out the work of varnishing and insulating the iron. A small polishing and grinding department is located near to the insulating and varnishing machines. Adjacent to this department is the erecting and testing department, where the Electro-Dynamic Company carries out the fitting-up of the lighting dynamos of the Consolidated Railway, Electric Lighting and Equipment Company. The entire western end and part of the north side of the main floor are occupied by the engineers' offices and the testing and laboratory department.

The main testing outfit is particularly complete and the instruments are sufficient in number and capacity to make any desired test. Four testing units in all have been installed, two of each of two sizes. Each unit comprises a table and a switchboard fitted with the necessary instruments and accessories. The smaller tables are each seven feet long, thirty inches wide and about twenty-one inches high. The larger tables are seven feet long, forty inches wide and about eighteen inches high. The widths and heights are so arranged that the machines overhang the tables slightly, and they are placed at a convenient elevation, so that any adjustment, such as setting the brushes, making connections and other details, may be carried out with great facility. The switchboard section accompanying each table has a motor and generator panel, and as a source of power supply the switchboard is connected to a 110-220-volt, three-wire circuit. On the motor panels special rheostats are installed, some of high resistance and others of large current-carrying capacity. The field rheostats are all connected in series, and as much as may be needed is cut into circuit. In the field circuit there is also an ammeter and switch for closing the field circuit, and a fuse. The armature circuit has a controller with reverse switch, fuses and two ammeters in series. For measuring the current of a motor running light, and for measuring the load current of small motors, the first ammeter is of fifteen amperes capacity. This is provided with a shunt switch, by means of which it can be made inactive when the current is beyond its range. The second ammeter is of such a capacity that it will carry the current for any motor to be operated from the board, and this is always left in circuit. On the motor panel also, for the separation of armature and field circuits, is a circuit-breaker and a double-throw switch for connecting to 110 or 220 volts. The generator panel has a field circuit arrangement similar to that of the motor panel, except that there is necessarily less resistance and fewer rheostats. The armature circuit includes an ammeter, a circuit-breaker, fuses, a set of cast-iron grid rheostats for holding the generator, and a double-throw switch, with which the generator load can be led to the rheostats or put back on the power line, as desired. The load rheostats are placed on the ceiling above the boards, and have terminal posts on the boards by which they may be connected in series, multiple or series-multiple. Each pair of boards is supplied with a voltmeter and leads long enough to effect voltage readings, insulation measurements or other measurements at any part of the table. Clear across the front of the boards, at a convenient height for either standing or sitting, there is placed a shelf, so that data, books, references or additional instruments may be handled.



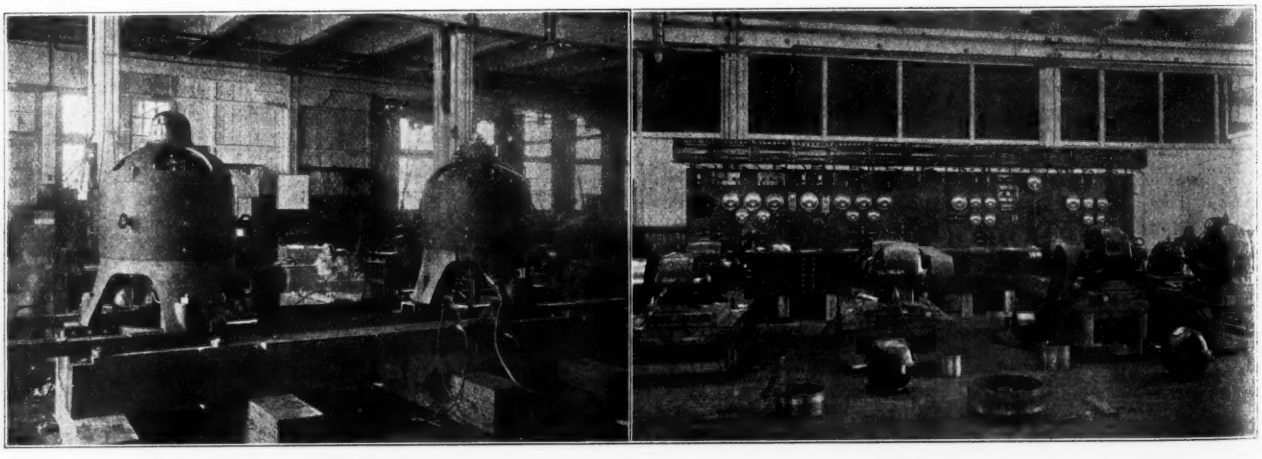
THE PLANT OF THE ELECTRO-DYNAMIC COMPANY, BAYONNE, N. J.

The space left between the general stockroom and the extreme western end of the

main floor is occupied by a toilet room and a storage-battery room which furnishes current for night lights and for special testing.

Two broad galleries run the entire length of the north and south sides of the building. These galleries are connected at the east and west ends by narrower sections. The offices of the company occupy the south gallery, running west. The offices include a large draughting room, a blue-print room, reception room, superintendent's department, and several private offices. Running along the south gallery, below the offices, and extending to the eastern extremity of the building is the department for light machines and small tools. This department extends across the east gallery and half-way up the north gallery. About the centre of the north gallery there is a special tool

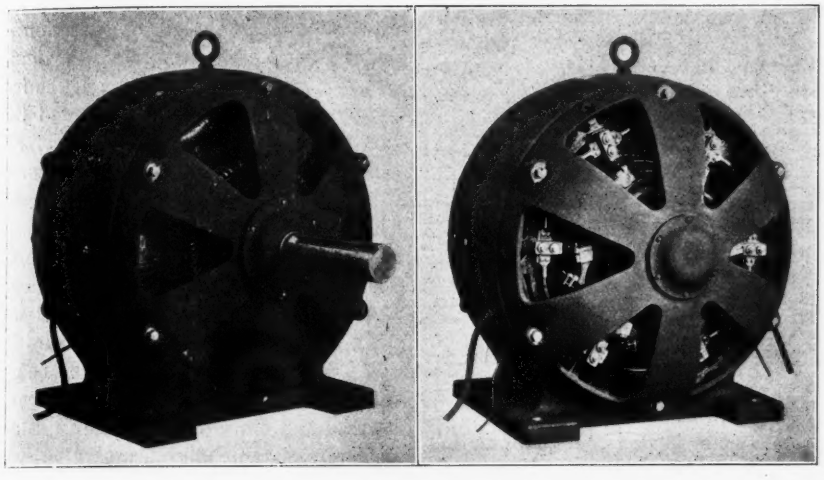
PLANT OF THE ELECTRO-DYNAMIC COMPANY, BAYONNE, N. J. 1—SOUTH GALLERY. 2—STOREROOM. 3—ERECTING DEPARTMENT, MAIN BAY. 4—SOUTH GALLERY, LOOKING TOWARD OFFICE.



PLANT OF THE ELECTRO-DYNAMIC COMPANY. VIEWS IN THE TESTING DEPARTMENT.

room, where jigs and tools required by the shop are manufactured. The western end of the north gallery is occupied by the winding and insulating department.

The building is served by a fifteen-ton, electrically driven crane manufactured by the Northern Engineering Works, Detroit, Mich. This crane has a span of thirty feet and runs the entire length of the building.



TWO VIEWS OF THE "INTER-POLE" VARIABLE-SPEED MOTOR.

The building is lighted on all sides by high, broad windows, and also by a monitor running the entire length of the structure. The artificial lighting is secured by means of arc and incandescent lamps. Power is taken from the plant of the Electric Launch Company, on the three-wire system, at 110-220 volts.

The company devotes itself mainly to the manufacture of the "Inter-Pole" motors and generators. The special adaptation of the inter-pole feature for variable-speed motors has brought the company into considerable prominence, and has made necessary the thorough equipping of this modern plant.

The introduction of the electric motor for driving machine tools some few years since emphasized the need of a reliable, efficient, variable-speed motor. With the old belt drive and cone pulley a wide range of speeds was obtainable, but only in steps. If, then, the electric motor is to replace the belt drive, it must not only accomplish all that the latter does, but it must be better. It should make available a sufficient range of speeds, and it is very desirable that the change in speeds should be gradual and not in jumps.

Moreover, under the conditions obtaining generally in machine shops there is considerable liability of overloading the motors, causing not only excessive heating, but injurious sparking. It is most essential, therefore, that a motor designed for shop driving should not only give the desirable changes in speed, so that any speed between the upper and lower limits might be obtained, but it should be designed on liberal lines, so as to reduce the danger of overloading to a minimum and so as to prevent sparking under all possible conditions. These requirements have been met, the maker believes, by the so-called "Inter-Pole" motor.

Some two years ago the Electro-Dynamic Company decided to build a variable-speed motor, and, realizing the severe requirements, adopted the design embodying the inter-pole. This is a small pole placed between the main field poles and wound with a series coil. The effect of this is to set up a field where normally the neutral plane would be the direction of this field being proper for reversing the current in the armature coils during commutation. As this field coil is connected in series with the armature, the intensity of the commutating field would vary with the load, and thus provide for commutating at all loads. The intensity of this field is independent of the strength of the main motor fields, and therefore the latter can be varied at will so as to change the speed without in any way affecting the commutation of the motor—in fact, the inter-pole performs its functions so satisfactorily that heavy loads may be thrown off and on the motor, or the speed controller changed quickly from the point of highest speed to the point of lowest speed, and vice-versa, without any sparking whatever at the brushes.

This inter-pole design possesses a number of advantages in addition to those of securing good commutation. In the first place, since the armature reaction which tends to set up sparking is balanced at all loads by the inter-pole, the air-gap may be made smaller than is customary, without danger of sensitive commutation; in fact, the air-gap now generally used is about three-eighths of an inch, which gives good mechanical clearance. Moreover, since commutation is always provided for, the inductance of the armature may be a little greater than is normal, thus allowing for a deeper slot and more turns per slot. This enables the diameter of the motor to be reduced, thus producing a smaller and lighter machine.

With this design there is no need to bevel the pole horns so as to provide a commutating fringe. The poles may be cut off square without producing sensitive commutation. This construction would set up humming, due to the sudden passage of a tooth into and out of the magnetic field, but this humming is avoided by setting the pole shoes a little askew, the pitch at the edge of the poles being about equal to the width of one slot and a tooth. Each tooth therefore passes gradually into and out of the magnetic field without the objectionable humming.

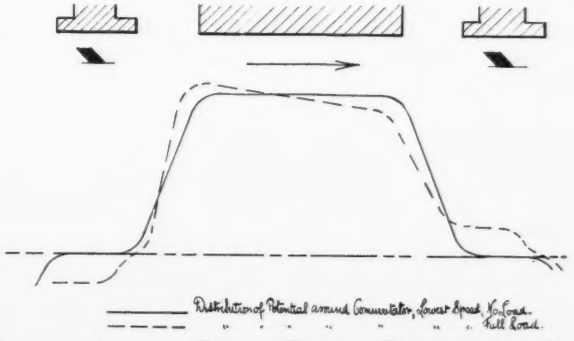


FIG. 1.—EFFECT OF AUXILIARY POLE ON MAGNETIC DISTRIBUTION AT LOW SPEEDS.

The effect of this inter-pole on the magnetic distribution around the armature is shown in the accompanying diagrams. In Fig. 1 the solid line represents the distribution at the lowest speed under no load. It will be noticed that the top of the curve is flat, and it has the normal shape, passing through the axis under the

brush. The dotted line shows the effect of loading the motor. The armature reaction, as is normal, raises the curve on the left and lowers it on the right, producing a typical sloping distribution curve. The curve thus drops off rapidly toward zero, but, before reaching the axis, the effect of the inter-pole is felt, since under load this is strongly magnetized, producing the hump shown there. From the figure it is seen that there is a considerable field under the brushes, and there is therefore an electromotive force set up in the coils during commutation.

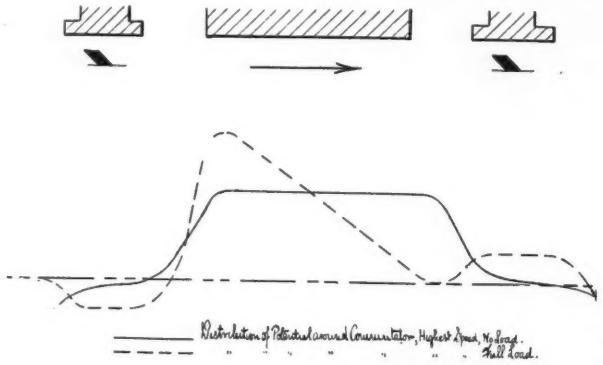


FIG. 2.—MAGNETIC DISTRIBUTION AT HIGH SPEED, SHOWING EFFECT OF AUXILIARY POLE.

Fig. 2 shows the character of distribution curve obtained at the high speeds. At these speeds the main field is weak; therefore the armature reaction is felt more severely. The hump before the solid line represents the conditions under any load. The curve is typical, flat-topped, and drops off rapidly toward the axis as the coils pass out from under the poles. The dotted line shows the effect of loading the armature with this weak field. The armature reaction is felt more severely, raising the left part of the curve more considerably, lowering the right more, so that the top of the curve slopes steeply, bringing the magnetization down practically to zero at the pole tip. But from this point on the curve rises again as the coil passes under the commutating poles. There are thus two positive waves and two negatives for each pair of poles. Obviously, a distribution such as would be obtained in this motor without the inter-pole in action would make satisfactory commutation utterly impossible. The motor could not run under this load.

In the type of motor which the company has been making there has been one inter-pole between each pair of poles, a four-pole motor having four commutating poles. Since, however, to produce satisfactory commutation it is only necessary to insert a commutating pole half the length of the main poles, half of the commutating poles may be omitted, the other half being made twice as long. A four-pole motor thus has two commutating poles, a six-pole motor has three. The commutating field in a four-pole motor is thus set up at two points only, but since each coil as it is commutated has one side at least in a commutating field, all conditions are provided for.

Fig. 3 shows two typical efficiency curves of "Inter-Pole" motors. The upper curve here represents the efficiency at the high speeds, and the lower at the low speeds. The difference in efficiency is small, considering the range in speeds, and is due principally to the increased copper loss in the field coils at the lower speeds. Since at these speeds the saturation of the field is run up very high, the copper loss increases quickly, but it also drops off as rapidly as the speeds are increased, so that an increase in speed of ten per cent will produce a much greater decrease in these losses. For this reason the curves of efficiency at intermediate speeds lie closer to the upper curve than one would at first assume.

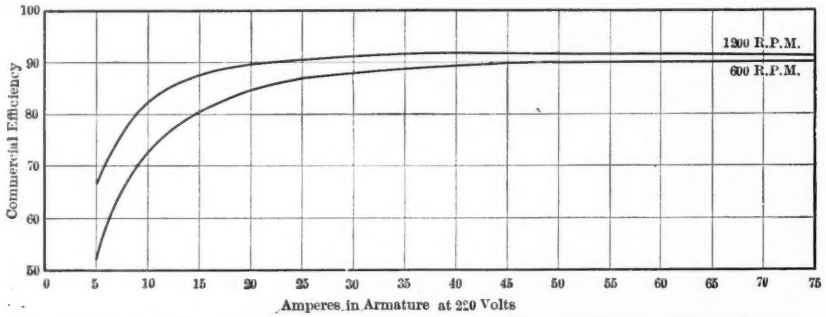


FIG. 3.—TYPICAL EFFICIENCY CURVES, "INTER-POLE" MOTORS, FIFTEEN HORSE-POWER, 220 VOLTS, 600 AND 1,200 REVOLUTIONS PER MINUTE.

These efficiency curves show an extremely creditable performance of the motors, which is obtained only by the greatest care in design, in selection of material, and in construction. Particular attention is paid to the selection of the iron for the armature cores. It is found that this varies considerably in quality, and constant watching is necessary in order to be sure of obtaining the best grades. The company has established the practice of calling for samples of material before placing an order and then testing each batch of iron as it is delivered. The company even tested foreign grades of iron, but found that iron could be obtained in this country as good as any that could be produced abroad. This care in selecting iron is especially necessary in constructing variable-speed motors.

The typical design of the motors is shown in the accompanying illustrations. The armature is drum-wound, the former-wound coils being supported on a strong cast-iron ring, to which they are firmly bound by band wires. The coils themselves are laid in the slots and held in place by fibre wedges. The commutator is ample in design and supported on a cast-iron spider, allowing free circulation of the air through it and out through the ventilating ducts in the armature and between the commutator leads.

The main field is of cast steel, which, due to its high permeability, enables a comparatively light casting to be used. This field casting in swept out in a boring machine, the pole-pieces are turned to fit and are bolted to its inner surface. The pole-pieces for the slow-speed machines are also of cast steel, but for the high-speed machines they are built up of laminated punchings so as to reduce the eddy current losses in the pole-faces.

The mechanical construction is neat and attractive. The styles made are either of the open or enclosed types. One feature which deserves particular mention is the use of ball bearings on all of the motors. These bearings are of the Hess-Bright silent type and are imported from Germany. The bearing consists of two cones, adjustable, between which are placed the balls, which are held apart by small springs, within which are placed asbestos wicks. This arrangement not only provides ample lubrication but gives

a certain flexibility to the bearing and allows the balls to adjust themselves without grinding.

The motors are made in any size from one horse-power up to 150 horse-power and in ranges of speed of from two to one up to six to one. The company also builds a constant-speed motor.

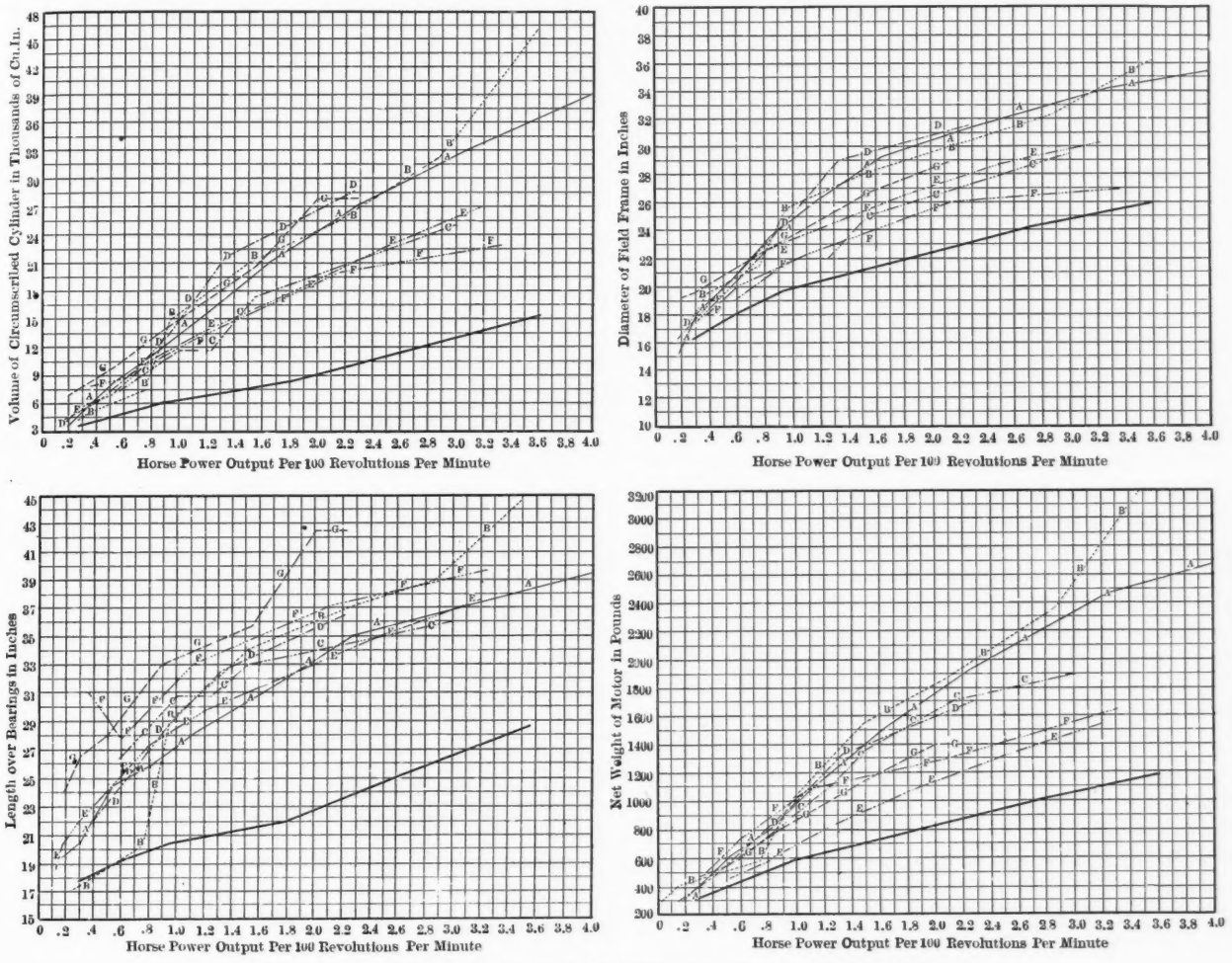
The variable-speed motors, while giving a wide range of speed, operate at a very constant speed with any particular setting of the rheostat. The commutating pole will naturally have a slight compounding effect which might tend to decrease the speed of the motor under load, but this is offset by the armature reaction on the main field. It is possible, however, by slightly shifting the position of the brush to obtain either a differential or a compound effect, causing the motor either to speed up or to slow down with changes in load. Normally, however, the brushes are set so as to give a constant speed.

The company is at present building three distinctive types of "Inter-Pole" motors. One is the regular horizontal pattern; one is a special machine with a bearing on one side only, made for direct attachment to a shaft for elevator and similar work; and the third is a vertical machine which has been designed for the driving of centrifugal pumps and similar apparatus. The accompanying illustrations show these various forms of motors. The first motors made by the Electro-Dynamic Company on the "Inter-Pole" system were built with cast-iron frames. The possibility of reducing the size and improving the operation of the motor by utilizing a steel frame and remodeling the various parts was carefully studied, and the first steel motor was run in January, 1905. Since that time twelve distinctive frames have been developed, giving the company 397 ratings. This, of course, includes combinations of speed changes with the various voltages and several classifications. The 397 ratings are for motors alone. At the present time no classification has been attempted of the generators.

The business of the company has developed so rapidly within the past six months that the factory has been driven to its limit. The motor has had a very hearty endorsement from every user. Among the large companies that have made installations of the "Inter-Pole" motor may be mentioned the following: National Elevator Company, Worcester Pressed Steel Company, Cambria Steel Works, Philadelphia Rapid Transit Company, Bement-Miles Works, Bullard Machine Tool Company, Gould & Eberhardt, General Pneumatic Tool Company, le Blond Machine Tool Company, Niles-Bement-Pond Company, Standard Wall Paper Company, and the Thompson-Norris Company.

The company has purchased a tract of land, about twice as large as that which it now occupies, to the north of the present location, and it is quite likely that next spring ground will be broken for the erection of new shops for the manufacture of this type of apparatus.

The engineers of the company have prepared some interesting charts showing some comparative measurements of the "Inter-Pole" motor. The heavy black line indicates the characteristics of the "Inter-Pole" motor, with the light dotted lines giving the characteristics of eight other standard lines. Fig. 4 gives the comparative volumes of direct-current electric motors operating at full load with temperature rises below the American Institute of Electrical Engineers' requirements. Fig. 5 gives the comparative field frame diameters of direct-current motors operating under the same conditions. Fig. 6 gives the comparative lengths over bearings, and Fig. 7 gives the comparative net weights.


Volume of Circumscribed Cylinder in Thousands of Cu. In.
Horse Power Output Per 100 Revolutions Per Minute
Diameter of Field Frame in Inches
Horse Power Output Per 100 Revolutions Per Minute
Length over Bearings in Inches
Horse Power Output Per 100 Revolutions Per Minute
Net Weight of Motor in Pounds
Horse Power Output Per 100 Revolutions Per Minute

FIGS. 4, 5, 6 AND 7.—COMPARATIVE MEASUREMENTS OF "INTER-POLE" MOTORS.

The officers of the Electro-Dynamic Company are: E. B. Frost, president; G. Herbert Condict, vice-president and general manager; Maurice Barnett, secretary and treasurer.

An Interurban Railway Distribution System.

By W. E. Winship, Ph. D.

THE choice of a distribution system for a modern interurban railway operating an infrequent service, under fairly high schedule speed, is a matter for serious consideration. On the score of comfort and safety to passengers heavy cars must be used, and the severe momentary demands complicate the problem materially. Quite frequently the method chosen of distributing power from the power-house to the cars has conditioned that the ratio of operating expenses to income is too high for the road to be able to show a good return on its cost and the subsequent expense of modifications for bettering this condition represents a heavy outlay.

On such a system, where no local service is supplied, rotary converter substations fed from high-tension lines necessarily operate under a poor load-factor, the output varying from nothing to the momentary demands of one, two or three cars with poor resulting efficiency. This method of distribution is really only suitable for a frequent schedule.

Quite recently alternating-current railway motors have been developed for this class of service with the idea of avoiding the losses and attendance associated with rotary substations. While this system is already in a fair state of development, it is reasonable to expect that the motor equipments and methods of control will pass through an evolutionary period similar to that of direct-current apparatus. The expense of maintenance is as yet an unknown quantity and will probably be much heavier for some time than for the corresponding types of direct-current motors. There are undoubtedly conditions which are satisfactorily met by an alternating-current distribution, the heavier maintenance expense of the motors being more than compensated by the investment, attendance and losses associated with rotary substations. There are, however, roads already developed where such a radical change in the equipment as the adoption of alternating-current motors would necessitate is out of the question.

There are a number of interuban roads with several power-houses or substations where the operating expenses are high, a fact often conditioned by the cost of power actually delivered to the cars. In some cases they are concentrating their power in fewer stations and erecting heavier copper or boosting the longer feeders, either by using series boosters or separately excited boosters and storage batteries, with the idea of reducing this portion of the operating expenses. The present article proposes to point out the possibilities of this latter method and illustrate the application to a certain interurban railway.

The simple series booster has rarely been satisfactory, the main reasons being that there is considerable lag in the booster, and owing to this fact the power to the cars must be applied and cut off gradually to avoid the flashing over of the motors; further, the losses in transmission are as the squares of the currents and are therefore greater than if the current were maintained at a fairly constant average value. The booster capacity, both in volts and amperes, is greater than when batteries are used; with an infrequent schedule the booster is running idle a large part of the time with a loss equal to or exceeding ten per cent of its rated capacity. In comparison the shunt or separately excited booster (usually excited from the station bus-bars) with a battery at the end of the boosted feeders is much more efficient. The current is fairly constant and the line losses are therefore a minimum, the volt and ampere capacity and the booster are both less and a fairly constant voltage is maintained at the battery. The boosted feeders may be tapped into the trolley at points before the battery is reached to avoid the double loss in transmission to the battery and return, the only precaution necessary being that the voltage at the nearest tap to the power-house must be less than the power-house voltage to avoid the possibility of reversing the generators. This may be ensured by inserting an overload-underload circuit-breaker in the booster circuit and adjusting the underload trip so that the circuit-breaker opens when the current is less, and therefore the line drop to the first tap in the trolley is greater than a certain value determined by the condition that this drop slightly exceeds the amount of boost. The battery voltage during service must be somewhat less than the generator voltage, its maximum is usually made some twenty or thirty volts less than the power-house voltage.

The efficiency of such a transmission may readily equal or exceed eighty per cent, a value which is considerably greater than that of a rotary converter system under poor load conditions when all the losses are considered. The battery attendance is negligible when compared with that of an equivalent substation. The economical limits of such a distribution system will depend on schedule conditions. The line may readily exceed fifteen or seventeen miles on either side of a power-house or substation, and when two stations are necessary they may be thirty or more miles apart. The resultant station economy may be considerably improved by this method, as the battery location may be chosen where there are grades or frequent stops or where, for any reason, cars are likely to be bunched. By thus

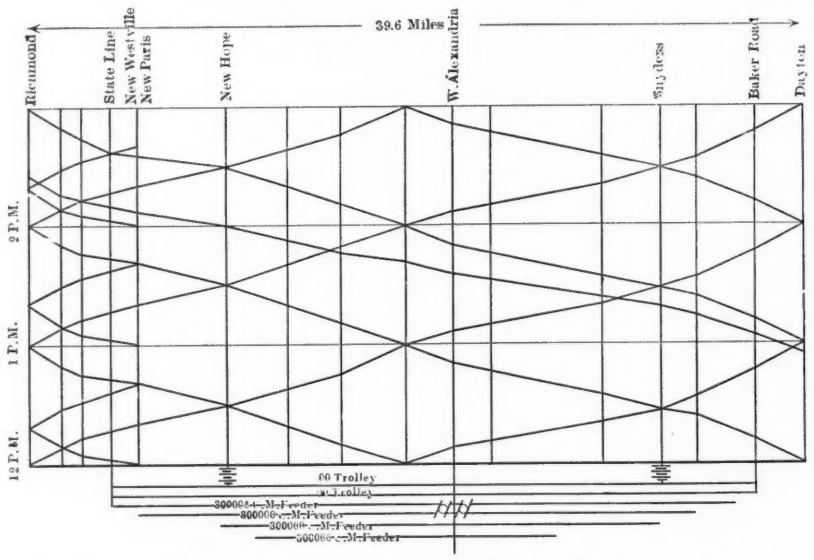


FIG. 1.—LOAD CHARACTERISTICS OF INTERURBAN RAILWAY DISTRIBUTION SYSTEM.

removing the heavy peaks the station apparatus will be operated under good load conditions. The possibilities of this method are well illustrated by the results obtained by the Dayton & Western Traction Company.

On this road a regular hourly service is operated between Dayton, Ohio, and Richmond, Ind., a distance of 39.6 miles, of which 2.6 miles in Dayton and approximately three miles in Richmond are operated on city tracks where the speed is limited by ordinance and the interference of city cars. The entire run is made in two hours. In addition to the regular service limited cars are run from Dayton through to Indianapolis, the run from Richmond to Indianapolis being made over a connecting system. The running time from Dayton to Richmond is one and one-half hours for this service. The cars weigh approximately thirty-three tons and are equipped with No. 56 Westinghouse motors. A twenty-four-ton car is operated hourly between Richmond, New Westville and New Paris. On holidays and special occasions half-hourly service is operated between Dayton and Richmond.

The power-house is located at West Alexandria and feeds in either direction to Baker road and Indiana state line. The distances, feeders, schedule, etc., are shown in Fig. 1.

Previously to the installation of the batteries, series boosters were operated on the two longer feeders on either side of the power-house. Their fields were rewound at a very slight expense, and are now excited from the station bus-bars. The station voltage is between 610 and 615 volts; the booster voltages are approximately 185 volts on the Dayton end and 200 volts on the Richmond end. Two batteries, each consisting of 266 cells Gould storage batteries, having a capacity of 240 amperes for one hour, were installed, one at Snyders's and one at New Hope, the installation being completed during the latter part of July, 1905. Comparing the results since this time for the months of August, September and October, with the same months of the preceding year, there has been a reduction in operating expenses of over $1,000 per month with a growth in business of approximately thirty-two per cent.

This reduction is due to a number of causes more or less directly a result of the batteries. The generator load is much more constant and varies ordinarily between 420 and 980 amperes, as compared with a variation between 125 and 1,200 amperes under the same conditions before the batteries were installed. Formerly the load occurred in cycles, being heavy during a half hour and light the succeeding half hour. It was necessary to operate four boilers, whereas, due to the more steady load, it is now carried by two boilers. The boiler-room force has been reduced by one man and the time of the rest has been shortened. The station output is practically the same now as it was during corresponding periods in 1904, but a heavier freight business is handled, a small lighting load has been taken on and an electrically driven rock-crusher installed. These additions indicate that the car consumption has been decreased by about ten to twelve per cent, due to improved line conditions. The schedule is now satisfactorily maintained, which conditions did not exist previously. Battery voltmeter charts are shown in Fig. 2 and Fig. 3.

The output of the power-house, including car lights and air-brake motors, but corrected for station and barn lighting, shop motors, etc., is 3.055 kilowatts per car-mile or 92.5 watt-hours per ton-mile, a figure which is quite low for this type of service. The success in operating this road is largely due to careful attention to details on the part of the management. For example, the judgment of the motormen in applying currents is exceptional, and a result of thorough training. The ordinary maximum currents of a single car are within 275 amperes, and nearly always within 325 amperes. Considering the weight of the cars and that there are a number of grades, including several of some lengths amounting to five and six per cent, these results are remarkable.

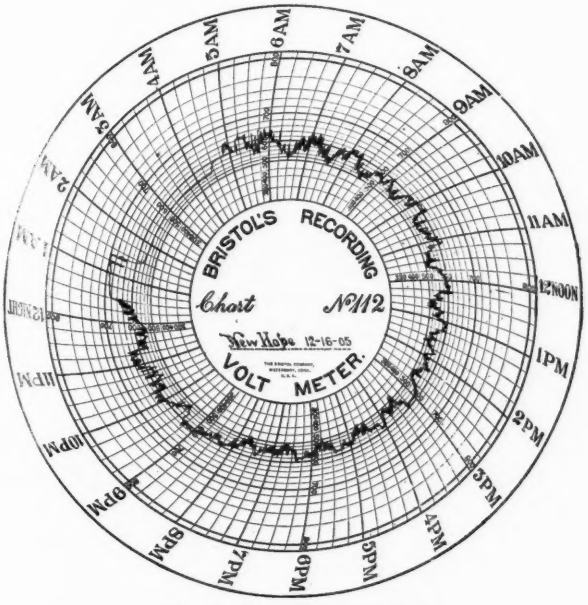


Fig 2.—New Hope Battery.

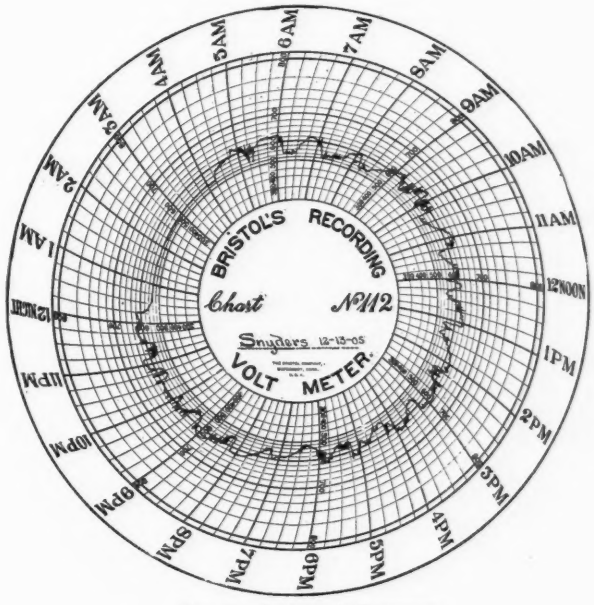


Fig. 3.—Snyders's Battery.

Marconi Lecture before the New York Electrical Society Postponed.

Cable advices from England report that Mr. William Marconi is severely ill with influenza. Under the absolute orders of his physician he is not to undertake a sea voyage for some time to come. The lecture scheduled for delivery before the New York Electrical Society on January 16 is therefore postponed. Mr. Marconi will be in New York in March, and he has promised to deliver his lecture to the society in the third or fourth week of that month.

The Plant of the Trumbull Electric Manufacturing Company.

THE Trumbull Electric Manufacturing Company, Plainville, Ct., has recently completed a modern three-story and basement brick building for the accommodation of its growing factory

FIG. 1.—ORIGINAL PLANT OF THE TRUMBULL ELECTRIC MANUFACTURING COMPANY.

FIG. 2.—TWO YEARS LATER.

FIG. 3.—THE NEXT ADDITION.

equipment. This company started to manufacture rosettes in September of 1899. Fig. 1 shows a view of the earliest building in which this company's product was made. This building was a rectangular wooden structure of one story, the machinery being driven by a Baxter engine which was located in one corner of the room. A little later the company started to make type B switches, and the old engine was taken out, a new engine room being added to the original building, the plant then having the appearance shown in Fig. 2. The next enlargement, in 1903, was to add a two-story and basement ell to the old building. At this time the company began making switchboards. Fig. 3 shows a view of the building as it stood at the end of 1903.

At present the original room, in which the plant started, is used as the storeroom for housing all the copper used on the switchboard work. In the two-story and basement ell the basement is used for a storageroom for the slate for the switchboard work, of which a large assortment is carried in stock.

On the first floor there are set up the machines for cutting and trimming the steel parts of cabinet boxes, grinding and buffing machines, drilling-machines for making bolt holes and screw holes in the slate, and in this department also there is mounted and assembled all of the heavier switchboard work.

On the floor immediately above this is the cabinet department, where the wooden

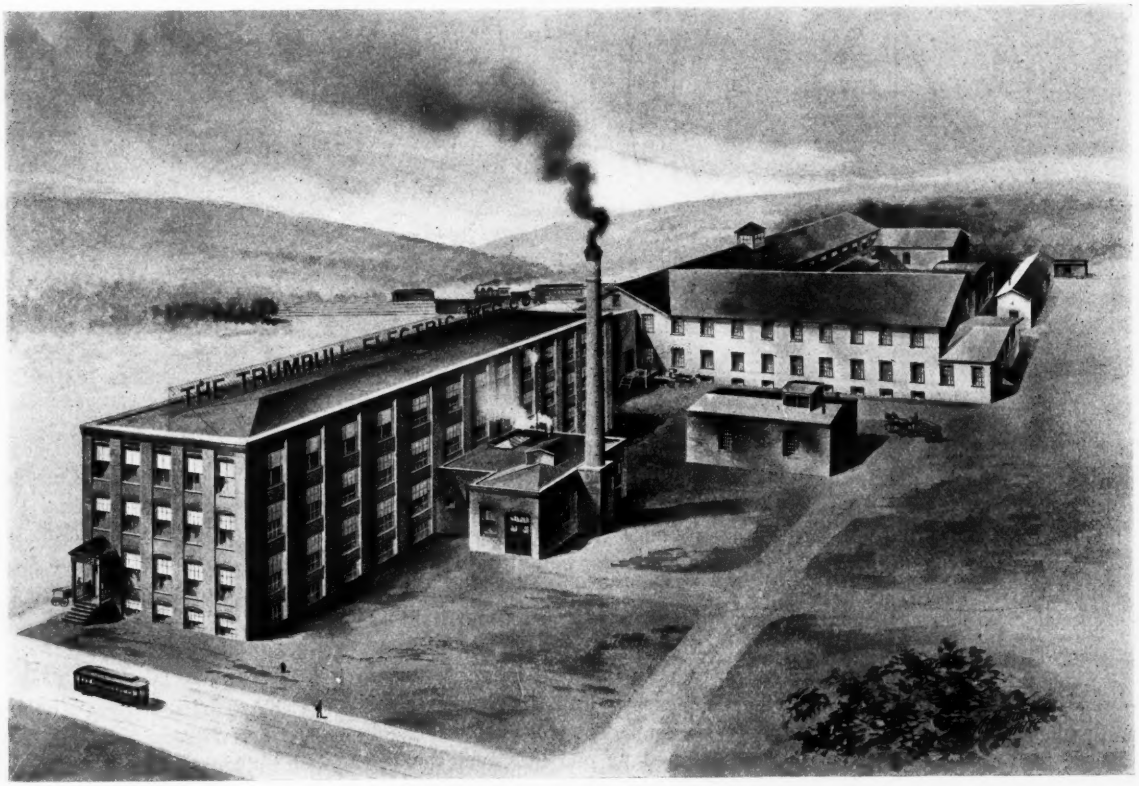


FIG. 4.—PRESENT PLANT OF THE TRUMBULL ELECTRIC MANUFACTURING COMPANY.

trims for the cabinets and switch boxes are made. The second story of the original building is used for a storeroom for finished stock.

The main building of the plant, as it stands to-day, is of brick and slow-burning mill construction. Each floor is connected to the old building by a covered arcade. The basement is utilized as a receiving room for slate for the switch bases, one side of the basement housing the slate-drilling machines. In one end

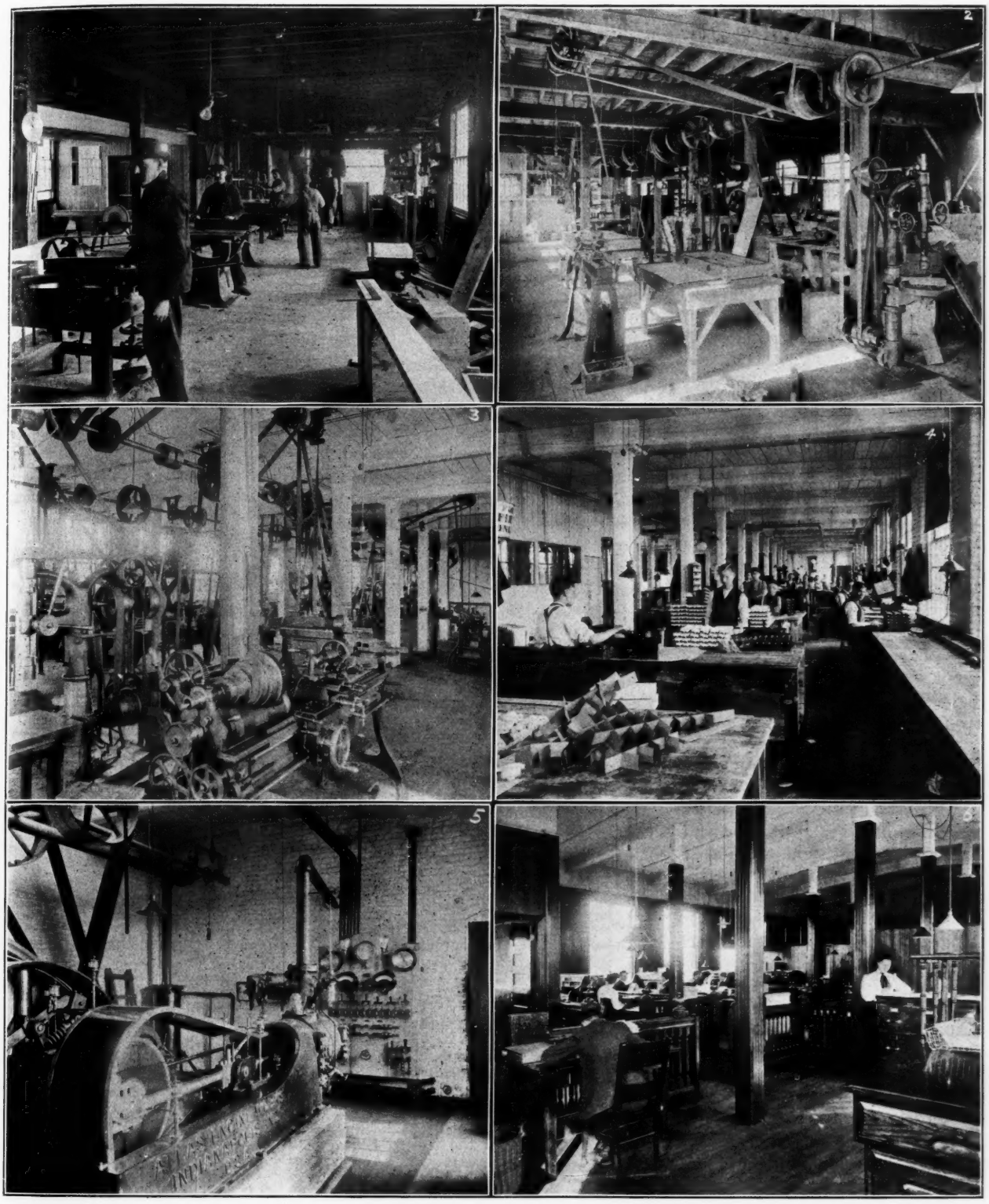


FIG. 5.—VIEWS IN THE WORKS OF THE TRUMBULL ELECTRIC MANUFACTURING COMPANY. 1—THE CABINET-MAKING DEPARTMENT. 2—THE SWITCHBOARD ASSEMBLING AND WORKING DEPARTMENT. 3—THE MACHINE ROOM, MAIN FLOOR. 4—ASSEMBLING DEPARTMENT, SECOND FLOOR. 5—ENGINE ROOM. 6—GENERAL OFFICES.

of the basement there are located two centrifugal exhausters exhausting air from the buffing room, which is situated on the first floor immediately above. A plunger elevator serves all floors and the basement.

The first floor of the main building is equipped with modern machinery, both standard and special, for the economical production of the metal parts used in the various devices. The benches are arranged around each side of the room so that throughout the day there is plenty of light from high, broad windows. The electric lighting system is very complete. All drops are equipped with cord adjusters made by the company, which enable the workman to adjust the lamp at the proper height from his work. The lighting is so arranged that there is a drop from eight feet in every direction throughout the entire factory. Pendant incandescent lamps with reflectors are placed at frequent intervals immediately over the benches. One portion of the main floor is devoted, as was noted above, to the buffing room, and adjoining the buffing room are the dipping and plating departments.

As may be seen from the accompanying general view there is a one-story ell built out from the first floor of the main building, which houses the power equipment. Power is furnished by a four-valve automatic Atlas engine, which drives by belt a main shaft running along the entire length of the main floor. From the main shaft a belt drives an auxiliary shaft, from which smaller countershafts are driven for the various presses and other machines. The flywheel of the engine is belted to a jack-shaft, from which a belt drives a twenty-seven-kilowatt Crocker-Wheeler generator delivering 125 volts, direct current. This generator supplies current for lighting the shops and for the motor which furnishes power for the machines in the switchboard department. The engine room also contains a blue marble switchboard, upon which are mounted a Bristol recording pressure-gauge, a water-gauge, steam-gauge, Westinghouse voltmeter and ammeter, generator field rheostat, service switches and a double-throw main switch for cutting in the city service from New Britain, Ct., when power in the factory is shut down.

The boiler room contains two horizontal tubular boilers delivering steam to the engine at about eighty-five pounds pressure per square inch. The boilers are equipped with automatic damper-regulators. These boilers also supply live steam to heating-coils in the enameling room, and in the winter the exhaust steam is used for heating the building, supplemented by live steam in very severe weather. Adjoining the engine room there is a fireproof brick tool vault, wherein are stored stock dies. All the wiring is carried from the switchboard in pipes to distributing boxes on each floor. From the distributing boxes the wires are carried on cleats to the respective drops.

The various processes of assembling are carried out on the second floor. The same scheme of lighting prevails on this floor as was noted for the floor below. In addition to the assembling department, the second floor contains the lacquering department and a department for the assembly of panelboards.

The top floor, or third story, is devoted to the general office and drafting room and the stationery storeroom.

The enameling room is located in a separate building about a dozen yards from the main plant. In this room the slate is scoured and made ready for whatever finish is desired. From this point the slates are passed back to the assembly room. This room contains several ovens, the heat being furnished by live steam coils.

Fig. 4 shows a view of the present works, and Fig. 5 shows a number of views in the different departments. The company is now manufacturing switchboards of any capacity. In addition to this there is turned out a very complete line of iron service boxes, special cabinet switches and standard switches from fifteen amperes up to 2,000 amperes capacity in all styles; porcelain base switches and battery switches, fuse blocks, fuse holders, pendant push-button switches, flush receptacles, fused and fuseless rosettes, plug cutouts, enclosed fuse cutouts, combination switches, panel cutouts and panelboards.

The New York office of the company is located at 136 Liberty street and managed by Mr. Thomas D. Watson. A complete stock is carried at this office for immediate distribution.

The company also has, in addition to traveling salesmen in the United States, a salesman in South America. Their South American and Mexican trade has been built up very extensively during the past two years in addition to an increased foreign trade.

The officers of the company are: F. T. Wheeler, president; J. H. Trumbull, treasurer, and Henry Trumbull, secretary.

SOME ELECTRICAL DEVELOPMENTS IN RAILWAY TRACTION.

BY F. M. FEIKER.

Probably no question has occupied as prominent a position in the eyes of the engineering world at large as the electric traction developments which have marked the passage of the year 1905. Not only have great strides been taken in general advancement of the urban and interurban trolley system, particularly in the South and West, but also notable progress has been made in the electrification of existing steam roads, both in terminal work and long-distance haulage. The most characteristic feature of this electrical development, perhaps, is the breaking away from the more or less traditional direct-current systems for railway work and a broader application of electricity as a motive power to meet individual requirements. This point has been emphasized by many of the most prominent electrical engineers. With a possible exception, there have been no theatrical announcements of change, but rather a general falling into line of the great railroad companies.

This electrification of railway lines has been classified broadly under two main headings—direct-current and alternating-current systems. Strictly speaking, these terms are somewhat misleading, inasmuch as the direct-current system very often includes alternating-current transmission, but it has become common practice to style the system as either direct current or alternating current, according to the type of motors used on the car without regard to the methods of distribution of current. It is in the field of alternating-current traction that the announcement above referred to has taken place. The decision of the New York, New Haven & Hartford Railroad to equip electrically its terminal facilities at the Grand Central station was not so much of a surprise as was the fact that alternating current had been decided upon as a motive power.

While the alternating current is still in an early experimental stage for the equipment of locomotives, it has been adapted with apparent success by several roads in the West and South. The application of the alternating current in these cases is the result of its fitness in these specific instances, and serves to corroborate the statement made in the introductory paragraph as to the broader method of treatment of electric traction. At the same time there are but few of these lines in operation in comparison with the great

number of direct-current equipments, and those roads which have adopted the alternating-current system may still be judged as being in the experimental stage.

On the other hand, while there have been no radical changes in the direct-current type of railway installation, its use has spread widely during the year just past. The great changes incident to the electrification of the Grand Central terminal at New York by the New York Central Railroad, inaugurated during the year 1903, have this year been progressing rapidly. The first big direct-current locomotive built by the General Electric Company in conjunction with the American Locomotive Company at Schenectady, N. Y., for this service, has completed the first 25,000 miles of its official trial trip of 50,000 miles. Such has been the success of this first half of the test that there will be no question as to the ability of the locomotive to fulfil the requirements imposed. It has made a most remarkable record for an electrical locomotive embodying such radical principles of design.

Along with the application of direct current by the New York Central for the improvement of its terminal facilities, there have been other developments looking forward to the general electrification of steam lines. A portion of the West Shore railroad between Syracuse and Utica, N. Y., is being electrically equipped for passenger service. In this case, while electricity will supplant steam for passenger service, steam freight haulage will be continued for the present in conjunction with the electrical equipment for local and express passenger systems. This combination of freight and passenger trains has introduced special problems, one of the most important being the method of using the overhead trolley. The engineers of the General Electric Company who had charge of the work decided to suspend the trolley line at the side of the track so that it would not interfere with the brakemen on the steam-drawn freight trains.

Another detail which has received much attention of late is the question of increasing the voltage for direct-current work. Direct-current motors are now being wound and insulated for operation on 600 to 750 volts instead of the ordinary voltage of 550, so long standard. Every such increase of voltage lowers the cost of installation by saving feeder copper, and there seems to be an indication that a voltage as high as 1,500 may be used.

More or less interlinked with this question of voltage is that of furnishing current to the motors. Since the general adoption of the third rail for supplying heavy currents to rapidly moving trains, several important questions have arisen and the past months have witnessed the solution of many of these difficulties. Both the New York Interborough and New York Central equipments have the protected third-rail system, the latter with the moving contact running beneath the rail.

Passing now to the application of electricity to trunk lines, toward which there is a gradual movement, the recent announcement of the Pennsylvania Railroad to electrify a part of its service marks another milestone passed in the onward march toward this goal. In this case the march is to the sea, as the proposed electrical service is to be established between Camden and Atlantic City, N. J. An express and local service is contemplated and the contracts have been let to the General Electric Company. This is an instance where both the third rail and trolley will be used and direct current will be supplied to the motors at 600 volts from substations located at proper intervals. This installation also calls attention to the increasing use of the steam turbine for railway power work. The current is to be transmitted to the stations at 33,000 volts and twenty-five cycles from a power-house located at Camden, containing a Curtis steam turbo-alternator equipment having a capacity of about 6,000 kilowatts.

Aside from these particular examples of electric railway engineering, the steam roads have brought forward a combination solution for certain problems which presents several interesting features as a go-between. In sparsely settled districts the initial expense of installing an electrical equipment has deterred many steam roads from electrifying their branch lines. Such lines are better and more economically served by single cars operating at frequent intervals than by steam trains. To meet the requirements a self-propelled car independent of a feeder system seems particularly well suited. The gasolene engine best meets these demands for an economical power, and, combined with an electric generator and motors, presents also a flexible and easily controlled system. Such a gasolene electric combination is now under way at the works of the General Electric Company and its trial operation augurs well for the success of this interesting offspring of the old year.

Not only has definite advance been made in the engineering details which have been outlined, but the year just gone has seen the inauguration of other plans in the electric railway field of a social and economic nature, in general, looking toward the safety and peace of mind of the riding public. Certain electric lines have established schools of instruction for motormen where more thought is given to their knowledge of the equipment, beyond the fact that one handle governs the power while the other is useful in stopping the car. Elementary electricity is taught and the man has some idea of what the "juice" is, in addition to instruction of a practical nature which makes him understand that starting and stopping the car properly has as good an effect upon the motors as upon the comfort of the passengers under his care. Among other things more attention has been paid to car construction and equipment. After costly lessons, underground cars especially are designed so as to be fireproof, being built of steel throughout. All these things tend to increase the sense of security of the passenger and consequently add nickels to the coffers of the operating company.

Another point perhaps of more interest to those who live near the car lines than to the passengers is the question of the reduction of noise upon elevated tracks. To a dweller of the cities the fact that a more or less silent elevated train is within the scope of practical engineering will be hailed as one of more than passing interest. That as great a city as Chicago should seek expert advice on this question surely means that the questions of general welfare are coming more and more to the front.

So it is evident that electric traction in all its phases has advanced much along every line. The continued adoption of this form of energy as the motive force for the transportation of the world means the steady betterment of mankind. Already this clean, rapid and frequent electric service is widening the city limits and bringing the business man nearer the pure air and saner living conditions of the country. This is not prophesy, but actual fact. The process has begun and the announced intention of the Erie Railroad to electrify a portion of its lines in southern New York will eventually lead to the application of this power to all the suburban lines. What is true of New York city holds good for all great centres of population. This year witnesses the opening of the Philadelphia subway, following the New York development of the year preceding. Thus each year brings nearer the general electrification of all traffic. Is it time for the historian to gather material for to-morrow's book, the "Rise and Fall of the Empire of Steam?"

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

BY PERCY INGALLS.

It is only within the last few years that central stations have awakened to a comprehending sense that they are not immune from the need of good and strenuous advertising.

To profit by the experience of others is the prerogative of the wise, and perhaps that is why central station managers are realizing to-day that to sell juice they must take the bull of publicity by the horns and force the public to appreciate the benefit of electricity over other modes of illumination and power.

To foster a desire and to create a demand where no demand exists, these are the ultimate ends of all advertising, whether for bread and cheese or electric current.

It is this demand-creating element that makes any advertising campaign of value to central stations.

The people who now illuminate their homes with electricity because they know it is the right light and those who now use it for power because they realize its efficiency are greatly in the minority to those who, knowing little and appreciating less about our commodity to-day, will be real or prospective customers, under the influence of a hustling advertising campaign, a year from to-day.

To create the desire and then the demand for electricity the prospect must be reached not once nor twice nor three times, but until he has been entered on the books as a customer.

Most of the larger companies are realizing this, though, to gain the same point, they are planning their campaigns on different lines.

The ideal follow-up system is the one that keeps hammering until the idea of electricity is driven into a man's mind so deep that it can not be eradicated until he has installed the service.

Take, for instance, so small a matter as a porch light. To many people the thought of this convenience would never occur as a necessity until its advantages were attractively presented. The first suggestion would pass unheeded, the second would mean but little, but after continued appeals its good qualities would begin to percolate through and steep itself into the thoughts of the householder. Every time he went out of his door at night he would think of the light, when he came home late he would think of the light, when guests arrived he would wish he could push the button and light them in and out. The desire is father to the thing. Pretty soon he would telephone for estimates.

That is the result in a small way that all advertising campaigns should seek on a larger scale. After all is said and done the greatest factor when considering advertising is "results." To attain this there must be a connecting link, close, strong and insoluble, between the soliciting and advertising departments or a failure is imminent.

In framing its campaign each company has local conditions and the scope thereof is great. In discussing advertising each central station man must of necessity talk more or less from his own experience. And so in speaking of a specific advertising campaign I speak from experience of the company with which I am familiar.

When we outlined our definite new business campaign two years ago we began by getting into closer and more harmonious touch with the sales department.

The interest of our solicitors was focused on three specific campaigns—electric power, electric signs and store lighting and residence lighting. Mailing lists of prospects were carefully revised with the result that the small workable lists then started have had an opportunity to grow larger each year, unhampered by an initial list of "dead names."

In outlining the campaigns the monthly bulletin was made the basic mailing and this was supplemented by a monthly calendar, *fac simile* letters and a series of circulars, booklets and mailing cards.

The letters always bore the signature of the local agent and carried a return post-card, sometimes stamped and sometimes not. Occasionally stamped envelopes were used to stimulate a reply.

This campaign was so arranged that every person on the list received a mailing of some kind every two weeks. At first the number of replies came rather slowly, but as the campaign progressed the strength of its system was demonstrated by the continued increase in replies and in style of replies.

The solicitors were rather inclined to resent the first invasion of a specific advertising department and were rather lukewarm over the advertising proposition, but as the work progressed and they saw its stimulating effects on their sales they grew enthusiastic. They began to offer suggestions, which were gladly received and often incorporated in the literature sent out.

The campaign for this company was used and is still continued in every city and town where its service is in operation. In this way it is possible to judge the effect of systematic advertising in localities of varied local conditions and populations. The proportionate results attained proved to us conclusively that such work is equally advantageous in small towns and large cities. It is tenacity, the continued application of the time-worn saw, "if at first you don't succeed try, try again"—or in other words it is the "keep hammering" policy that wins out for central stations.

Every live prospect on a list is a prospect as long as he is above ground. Don't let go until he is landed. He may not need nor want electricity to-day or next week, but six months from now he may be a large user of current. And an advertising campaign laid out by experts in this field along lines that embrace plenty of printers' ink, backed by brains, system and competent salesmanship, can not fail to show handsome gains in revenue at the end of each year.

"I think the one feature that has stood in the way of the general use of the electric laundry iron is the renewal of the heating unit when it burns out; and, as I have said before, this matter has been overcome and there is an iron on the market that is reasonable in price and which can be renewed at a small cost and small expenditure of time by anyone familiar with electrical or even mechanical contrivances.

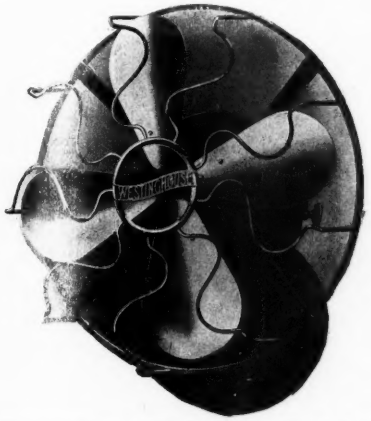
"The laundry iron can be used for general laundry work in the residence, and for a family of from two to four will use only from ten to fourteen units per month. They appeal at once to the men as well as the women as an economy—not an expense, and they will sell rapidly if put out right."—*R. L. Goodale.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Westinghouse Electric Fans for 1906.

The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., will present a largely increased assortment of electric fans for the season of 1906. The



WESTINGHOUSE 1906 WALL TRUNNION FAN.

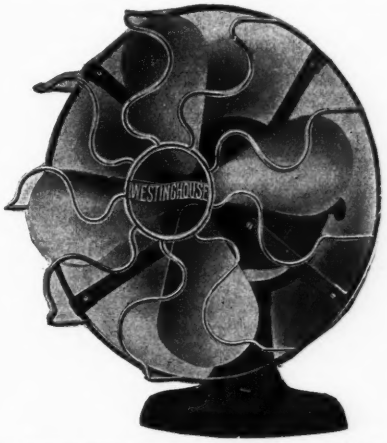
line has been designed with the greatest care, and embodies the results of the highest manufacturing skill and experience. The fans are made for both direct-current and alternating-current service, and in forms known as desk type, bracket type, ceiling type, floor column type and counter type.

The 1906 desk and bracket fans are attractive in appearance and substantially designed. A smooth surface is presented by the body and base, preventing the accumulation of dust. The fans are finished in polished black enamel, with guards and fan blades of buffed and lacquered brass. The blades of the 1906 model are a departure from the ordinary design formerly employed. They are constructed upon exact mathematical principles, and the angles are theoretically correct. The result is that the fan will give an even breeze across its entire front. The breeze is sent out from the fan in the shape of a solid cylinder of air, and there is little tendency to set up eddy currents. This determination of the correct blade angle has resulted in a high air delivery, while the total watt consumption has been decreased. The fan blades are protected by a guard of graceful design and substantial construction. The guard is secured in position by rigid arms, so that the entire weight of the motor may be supported by the guard without injury.

The motor is mounted upon trunnions whose line of support passes through its centre of gravity. The motor is balanced at any angle, and there is no tendency to turn over when the thumb-screw is loosened. The fan is secured in any position by two thumb-screws, one holding it at an angle in a horizontal plane, and the other at an angle in a vertical plane. The thumb-screw which secures the motor in a vertical position passes through the trunnion support a little below the axis, and bears against a boss on the side of the motor, affording a rigid and secure means of clamping the fans in any position. The thumb-screw which retains the fan at any angle in a horizontal plane is a recent modification, and is very efficient in service.

The 1906 fan-motor consumes a small amount of energy, illustrated by the fact that it costs about three-quarters as much to run a twelve-inch fan as to burn an ordinary sixteen-candle-power incandescent lamp on the same circuit.

By means of a simple adapter the desk



WESTINGHOUSE 1906 DESK TRUNNION FAN.

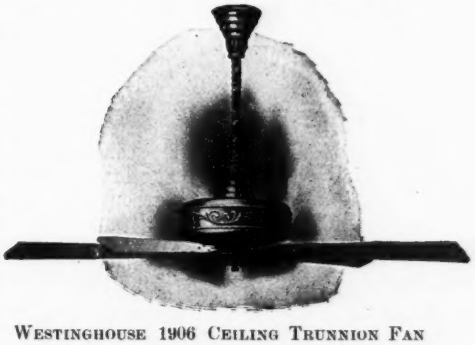
and bracket types of Westinghouse fans are interchangeable.

The motor used in the alternating-current desk and bracket fans is of the induction type with stationary primary and rotating secondary. The winding is made up of solid rods of copper inserted through the partially closed slots of a laminated core, and short-circuited by metallic end rings. There are no moving contacts and no electrical connection between the rotating part and the outside line. The motor has therefore no wearing parts except the bearings, making it durable and exceedingly simple, both in construction and operation. The primary is wound for either 110 or 220 volts, and for 7,200 or 16,000 alternations per minute. The 7,200 alternations motor is made with two bearings, which are of ample dimensions and automatically lubricated. In the 16,000 alternations motor the shaft carries the fan at one end and the secondary of the motor at the other, the two parts balancing each other on one bearing.

The switch employed is of simple design and substantial construction. It is made of moulded insulating material, of such form that it can not easily be damaged or thrown out of alignment. The handle projects through a slot in the motor base at the most convenient and accessible point. In starting with the alternating-current fans the start is made very readily whether the switch is in the high-speed position or in the low-speed position, obviating the danger of burnout because of failure and sudden restoration of power when the switch is set on the low-speed contact.

The alternating-current fans are arranged for operation at two speeds of approximately 1,625 and 1,300 revolutions per minute. The slow speed is obtained by the insertion of a choke coil connected to the switch contacts and in series with the motor.

The field coils of the direct-current motor are rectangular in shape, machine-wound and insulated by special treatment, reducing to a minimum the liability of breakdown. The armature is of the drum type, with slotted laminated core, and carefully insulated winding. The commutator is of approved design. It is completely enclosed by an easily removable dust shield. The brushes are of car-



WESTINGHOUSE 1906 CEILING TRUNNION FAN

bon of the highest quality, and the brush-holders maintain an even pressure and perfect contact. The shaft is of hardened steel running in bushings of fine bearing metal. There are two bearings provided

with an automatic oil return, which ensures abundant lubrication at every point, and prevents throwing of the oil.

The switch is so designed and constructed that it will withstand considerable hard usage without getting out of alignment. A handle of insulating material moulded to the end of the blade projects through the base. The switch and contacts are covered with an insulating disc which obviates the danger of short-circuit when the fan is placed on a radiator or any uneven conducting surface. The regulating resistance is made of wire of a low-temperature coefficient, wound on the outer edge of the enclosed porcelain switch base, and afterward enameled.

Three different positions of the switch-handle give three different operating speeds with a maximum of 1,650 revolutions per minute, a medium speed of 1,300 revolutions per minute and a minimum speed of 1,000 revolutions per minute.

The Westinghouse fans for 1906 for ceiling and floor mounting have many distinctive features. The cases are of graceful design and ornamental appearance, with a standard finish of black enamel and mottled copper. Other finishes may be furnished if desired.

The fan is made with four blades, which are set at angles calculated to give the highest possible amount of air for the lowest consumption of energy. The blades are securely attached to the moving element by screws which effectually prevent them from turning from their normal position.

There are three speeds of operation controlled by means of a resistance wound about the bearing-cup. Speeds of 200, 150 and 100 revolutions per minute may be obtained.

The switch is placed centrally in the underside of the fan body.

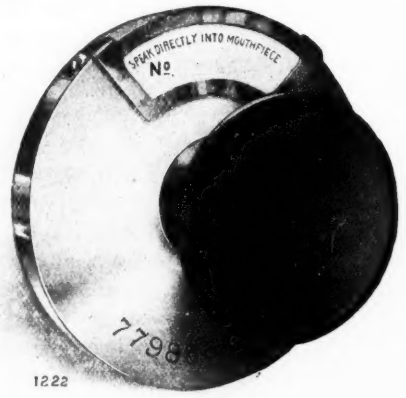
Fans of this type are made for operation from either sixty-cycle alternating-current or from direct-current circuits. The alternating-current motor is of the single-phase induction type with stationary primary and short-circuited secondary. The direct-current motor is substantially constructed with rectangular field coils and a drum-type armature. The commutator is especially well made. The brushes are of the finest quality of carbon, and so mounted that perfect contact and good commutation are maintained.

The rotating element is supported upon noiseless ball bearings, reducing friction to a minimum. A stationary shaft is provided, with a spiral groove, through which the oil from the reservoir is forced upward by the rotation of the armature.

The counter type fans are exactly similar to those designed for floor column mounting, with the exception that the shaft is made shorter.

A New Transmitter.

The Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., has placed on the market a new transmitter



NEW 7-A TRANSMITTER OF THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY.

designated as the No. 7-A. Unlike the usual form of transmitter construction, wherein one electrode is vibrated with the diaphragm, both electrodes are attached to the central point of the diaphragm, producing a variation in the distance between the electrodes of double the amplitude of vibration of the central point of the main diaphragm. This construction is claimed to produce a greater volume of transmission than if only one of the electrodes is movable. The transmitter is given such an adjustment that under ordinary tones of voice the volume is less loud than some forms of sensitive transmitters, but as the voice is raised the volume of transmission from the instrument is multiplied twofold. The highly polished carbon electrodes, with irregularly formed carbon granules, are enclosed in a practically moisture-proof case. No absorbent material whatever is used, so that the transmitter, when once assembled, should be entirely free from any bad effects due to atmospheric changes. It should, moreover, be equally efficient in any climate. The transmitter is made more durable by the use of an auxiliary moisture-proof diaphragm over the main diaphragm, preventing any chemical action of the main diaphragm due to moisture or alkali from the breath.

The illustrations show quite clearly the construction of the instrument. What conforms ordinarily to the front electrode is divided into two halves, each forming a terminal. The back disc, with the highly polished carbon, is used only as an electrical connection between the two halves of the transmitter. Fig. 1 shows the diaphragm with the connectors and cup attached. Fig. 2 shows the front view of the cup with the diaphragm removed, and the method of fastening the connectors to the electrodes. Fig. 3 shows the cup dismounted, with the granular carbon removed; *a* shows the front of the cup with the electrodes fastened to the auxiliary mica diaphragm; *b* shows the cup with the back carbon disc. Fig. 4 illustrates the parts of the cup; *c* is the back or neutral carbon disc; *d*, the cup; *e*, the separating ring; *f*, the electrodes and mica diaphragm, and *g* is the clamping ring.

The carbon electrodes used in this transmitter are of a special grade of dense carbon, so treated that it is of very low resistance. The carbon is securely soldered to the connecting discs without the use of salts or acid. The surfaces of the carbon buttons are highly polished, lessening the danger of the transmitter packing and preventing arcing. The carbon electrodes and also the granular carbon

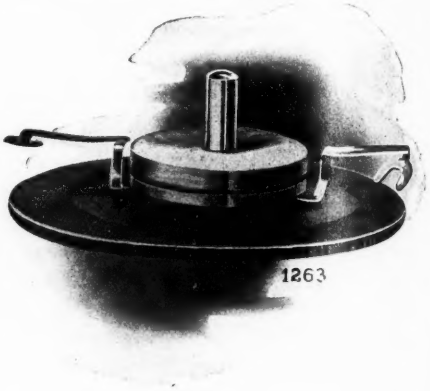


FIG. 1.—DIAPHRAGM WITH CONNECTORS AND CUP ATTACHED.

are manufactured by the company. Great care is exercised in selecting the raw material and preparing the product. The

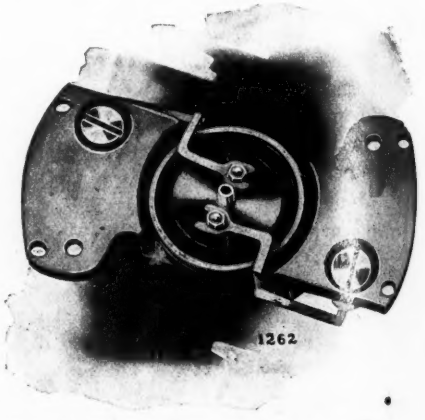


FIG. 2.—FRONT VIEW OF CUP WITH DIAPHRAGM REMOVED.

carbon is also thoroughly cleansed, so as to have it of such densities that it will be entirely free from dust.

The diaphragm is made of extra hard

aluminum, and is carefully straightened in a powerful machine. The diaphragm is also protected by a celluloid disc.

The auxiliary diaphragm for sealing the carbon cup is made of the best selected India mica, carefully gauged to thickness, and securely held in place by the clamping ring.

The rubber band for insulating the diaphragm against vibration from the retaining-case is made of high-grade rubber, ensuring its remaining soft and pliable, and preventing tarnishing the inside of the retaining-case.

The bridge is made from heavy solid brass, the binding-posts being insulated from the bridge with mica. The front is made from heavy brass, simply designed and accurately turned. The back is made of heavy sheet brass.

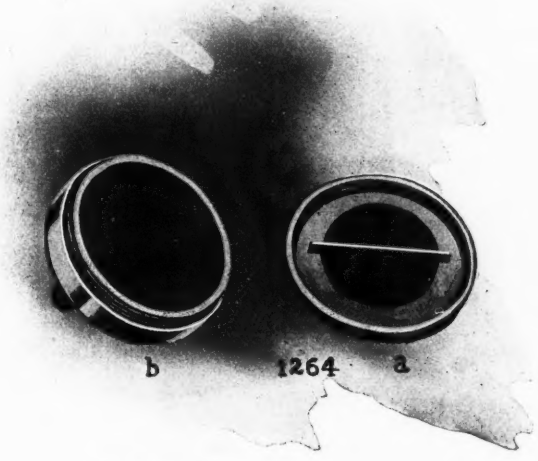


FIG. 3.—THE CUP DISMOUNTED.

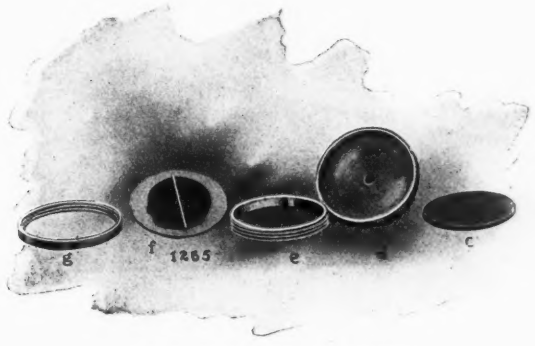


FIG. 4.—THE PARTS OF THE CUP.

Two New Electrolytic Meters.

Although the electrolytic type of electricity meter was the first to be put into commercial use, instruments of this class have been replaced by meters of the mechanical or motor type. The action upon which these meters depend is so easily applied that at first thought it would seem that a well-designed meter of this type should be not only accurate but inexpensive. Unfortunately experience has not proved this to be true. Two instruments designed to meet the conditions of accuracy have been proposed recently. In both it is the electrolyte which is decomposed and not the electrodes. These instruments are described in a paper by Mr. S. H. Holden, which was presented recently before a local meeting of the Institution of Electrical Engineers, of Great Britain. The first meter to be described was proposed by Bunsen who, in order to avoid the difficulties of measuring the amount of gas liberated during electrolysis, proposed weighing the electrolyte and thus determining its loss due to the action of the current. The electrolytic cell consisted of a thin iron vessel containing a solution of caustic soda and a pair of nickel electrodes. A small vent was provided at the top for the escape of gases. The cell was suspended by four light springs and counterbalanced by a weight. The loss of the electrolyte due to electrolysis was recorded on a dial by means of a rack and pinion. Meters of this type are subject to the objections that there is a relatively large loss of voltage at all loads; the meter is bulky, and it is necessary to refill the cell occasionally. On the other hand, it is accurate, simple and easily handled, and it contains no glass. A number of meters of this kind have been made and have given satisfaction over a fairly long period of use.

The second type of meter is designed to retain a constant volume of the electrolyte. It consists of a glass bulb, to the side of which is attached a vertical tube. This bulb is filled with a ten per cent solution of sulphuric acid to a height above the opening of the tube. A fairly large platinized electrode is placed in the bulb, projecting partially above the electrolyte. The second electrode is placed in the verticle tube. The volume of the bulb above the electrolyte is filled with pure hydrogen gas. Only the purest acid and distilled water should be used in preparing the electrolyte. To use this instrument it is first turned upon the side so as to fill the tube completely with acid. The instrument is then connected in shunt with a resistance carrying the current to be measured, so that but a small current passes through the meter. Electrolytic action takes place and liberates hydrogen gas in the tube, while the hydrogen gas in the bulb is absorbed by the anode and acts as a depolarizer, thus maintaining a constant volume of electrolyte. Other electrolytes have been tried, but none gives such satisfactory results as the sulphuric acid. Tests of the meter show a fairly straight characteristic, even though the current to be measured varies considerably. The meter is read by a suitable scale placed in front of the tube. To reset it it is only necessary to tilt down the tube so that it will be refilled with electrolyte.

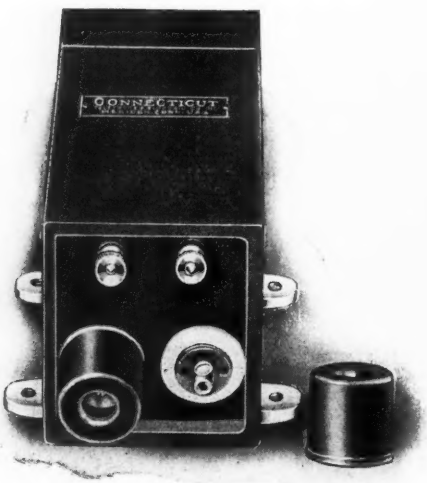
The Connecticut Spark Coil.

The Connecticut Telephone and Electric Company, Meriden, Ct., has for some time been experimenting with an electrical spark equipment for gasolene engines and

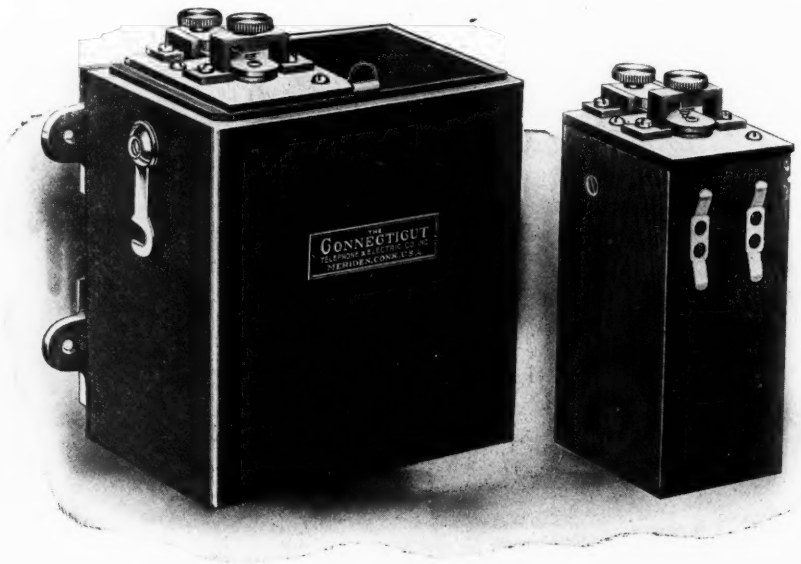
SINGLE-CYLINDER DASH COIL, COVER REMOVED.

has produced a coil for which it claims some unusual features.

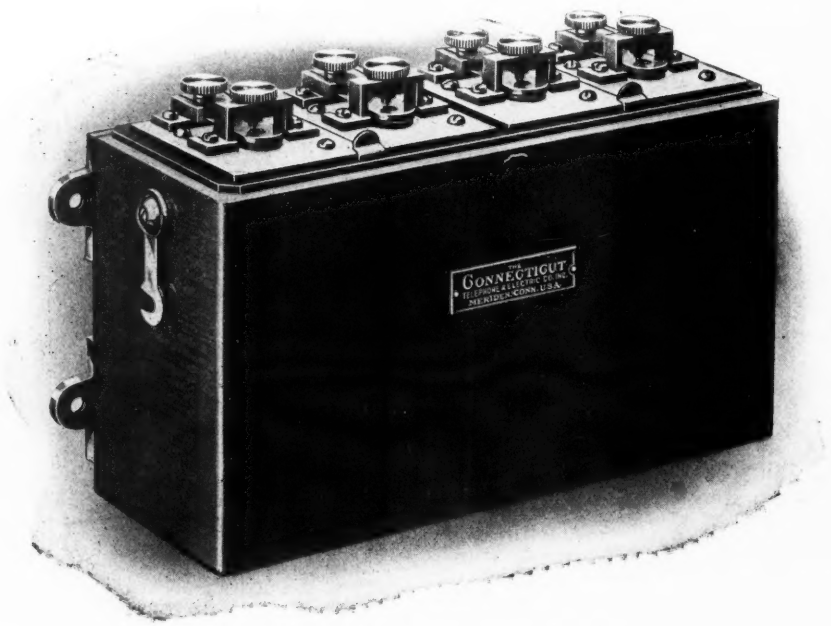
This coil is constructed upon the unit system. Each coil is individual and in no way connected with its neighbor. The coils are placed in cases, one unit for each cylinder of the engine. The units are interchangeable, self-contained, and the disconnecting of wires and the use of tools are unnecessary in removing a unit.



SINGLE-CYLINDER DASH COIL WITH BOTH SECONDARIES BROUGHT OUT, FOR USE IN FIRING A TWO-CYLINDER ENGINE.



TWO-CYLINDER DASH COIL WITH ONE UNIT REMOVED.



FOUR-CYLINDER DASH COIL, COVER REMOVED.

A retaining spring is thrown forward and the unit lifted from the case. The connections are made in the same manner when the unit is placed in the case. With this combination it is possible to carry an extra unit, and in case of trouble the defective unit may be replaced without stopping the engine.

The vibrator is simple in form and is constructed so as to give a rapid vibration, producing a very hot spark. The vibrator is adjusted by turning an adjusting thumb screw, which is self-locking, up or down.

The contact screw on the bridge is self-locking and will stay set in any position. No tools are required for these adjustments. When it becomes necessary to clean the sparking points or contacts, the two bridge retaining screws are loosened by one turn and the bridge slipped off, when the contacts are free for examination and cleaning.

All connection posts for primary and secondary circuits are made on the bottom of the case, leaving nothing but the working parts of the coil in view when the cover is removed. The secondary connections are mounted on hard rubber, both on the units and the cases. These posts are protected by a projection or petticoat extending all the way around the bottom of the case, so that there is no possibility of a leakage of the secondary current due to rain water running down, causing a partial or complete short-circuit.

The cases of the coils are made of selected mahogany, coated with six to eight coats of the best preservative finish, and oil rubbed to a lasting polish.

These coils are adjusted to consume not over one-quarter ampere when running. The greatest care is exercised in assembling the coils, and only the best material is used.

The Convention of the Northwestern Electrical Association.

The fourteenth annual convention of the Northwestern Electrical Association will be held at the Great Northern Hotel, Chicago, Ill., commencing at 9.30 A. M., Wednesday, January 17. It is announced that an unusually fine literary, business and entertainment programme has been arranged. The Western and General Passenger associations have granted a one and one-third round-trip rate from all points in their respective territories. Tickets to Chicago should be purchased and certificates secured from local agents.

A New Spark Generator.

The Atwater Kent Manufacturing Works, 42 North Sixth street, Philadelphia, is putting on the market a new spark generator, for which many features of distinct merit are claimed. It is claimed to do away with the commutator, magnetic vibrators and to reduce battery consumption seventy-five per cent. It concentrates into one unit the entire ignition system, except batteries and plugs, and is placed upon the dash in a neat-appearing box the size of an ordinary coil box.

Fig. 1 shows the mechanical vibrator, which is the principal feature of the new generator and which takes the place of both the commutator and the magnetic vibrators. There are two platinum contacts, one at D and the other on the end of the screw F. D is carried by the elbow lever C, which is pivoted at R, and the spring J keeps normally the platinum points apart. The point of F is stationary, although the screw F can adjust

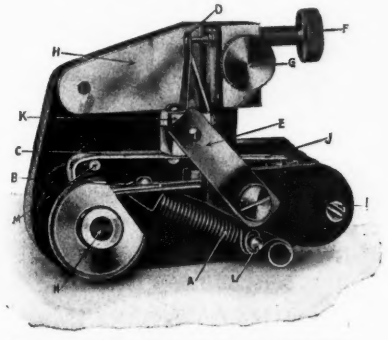


FIG. 1.—THE MECHANICAL VIBRATOR.

the space between the platinum contacts. On the shaft N (considering four cylinders are used) are four notches, resembling the notches on a ratchet. This shaft revolves counter-clockwise; as it does so, it carries forward over the top a small steel piece B, which we term a lifter. The moving forward of this steel piece brings the spiral spring A to a tension. No connection is made at the platinum contacts while this steel piece is going forward, but when it is released from the ratchet the spiral spring brings it back to its original position. When B starts on its backward path it raises the steel piece C, which, in turn, makes a contact at D; this closes the primary circuit and magnetizes the iron core in the coil. Before B reaches its released position it allows C to fall, thus breaking the contact at D, which discharges the magnetism of the core of the coil and produces a spark at the plug. When the next notch on the shaft comes round this operation is repeated, making but one spark for every explosion in the engine. Although the engine may be turning very slowly and the spiral spring A brought to a tension very slowly no contact is made until the spring is released. All of these parts are made very light, which allows for a very quick release of the spring, and as the duration of contact can last no longer than the time taken for the release of the spring, and as the time is always constant no matter how long the intervals between each release, it will readily be seen that a quick make and break is always accomplished, making a spark of constant size for all speeds of the engine.

So quick is the return of the spring from tension that it is possible to run this mechanical vibrator at a speed several times greater than any engine ever runs. As it is necessary for the lifter to be carried forward and released in order to make a spark, and when an engine is reversed the lifter is simply raised, sliding under the arm of the lever C, and no spark will be generated; therefore it is seen that the engine will not run backward. So quickly is the current made and broken that on the lowest speed of the engine the movement of the platinum point can not be detected by the eye. It will be seen that four sparks are made for one revolution of the shaft. With a four-cycle engine this shaft runs at half speed, so consequently only one spark will be made for each explosion.

A further description of the illustration will be that I is a screw which holds the advancing lever; E, a spring for holding the arm C in position and making a positive contact to this arm. All the vital parts of this apparatus can be taken out in ten seconds.

The current instead of being broken in two places, as it is in the ordinary timer and vibrator, is broken in but one place and this break is protected by the condenser of the coil, and practically no arcing occurs.

The apparatus is well designed and carefully worked out, experiments having extended over a period of more than a year. All the wearing parts are of hardened steel and each apparatus is thoroughly tested, being run a distance equal to two thousand miles at speeds varying from ten to a hundred miles an hour.

Fig. 2 shows the generating system complete, with the exception of the batteries. The side has been removed, also the cover, but this is the same as an ordinary coil cover. The four secondary wires U U U U are led from the binding-posts through the bottom of the box and thence to the spark plugs. The two primary wires are seen coming from the bottom, one leading to the battery and the other to the ground. These six wires are all that are necessary for the entire system. In the further side of the box is a removable, non-vibrator, high-tension coil. Contact is made directly from the secondary of this coil to the longitudinal distribution R. S is a shaft which is supposed to be connected to the "two to one" shaft of the engine, and drives the distributor and also the mechanical vibrator P, located on the top of the box and protected by the cover. T is the advancing lever which moves the mechanical vibrator for advancing spark. The cur-

FIG. 2.—THE GENERATING SYSTEM COMPLETE.

rent is led into and out of the mechanical vibrator by sliding contacts which allows this to be advanced and retarded without the use of moving wires. The advancing lever can be connected to the hand advancer on the steering-post in the usual manner. W is a two-point switch which allows the use of two sets of batteries if desired. Q is a button projecting from the front of the box, which is supposed to be quickly pressed and released to close the circuit in place of the mechanical vibrator; this is for starting the engine on the spark and the secondary current is distributed to the proper cylinder to start the engine. V is a hole for oiling the lower bearing and projects through the side of the box. The upper bearing is oiled by a hole at the top of the shaft.

The Roebling Soldered Rail-Bond.

The John A. Roebling's Sons Company, Trenton, N. J., has for some time past been developing a soldered rail-bond for use in bonding the return circuit of street railways.

The Roebling bond is a one-piece bond, all tinned to prevent corrosion, and it is equipped with a specially designed solder-pocket which renders its application very certain.

The bond is made of a flat strip of copper wound to the required dimension and shaped in a press.

In the Roebling bond a solder-pocket is formed on the face of the bond about one-sixty-fourth of an inch deep and somewhat smaller than the part of the bond in contact with the rail. This depression in the face of the bond is at the centre of the surface of contact, with a wall all around it. The solder is run into the depression or pocket by heating the bond to the proper temperature, and consequently takes or sweats to the surface. When the bond is applied to the rail, which has been made bright and tinned, the bond is heated by a torch until the solder softens and melts. As the solder melts the bond is pressed close to the rail by the clamp, the surplus solder is squeezed out, while the pocket retains enough to make an absolutely perfect union between the rail and the bond.

These bonds are made in various forms for application to different types of rail. Type A bond is designed for attachment to the outer side of the ball of a T or girder rail. Type B bond is designed for attachment to the web of the rail under the fish-plate, or it may be attached to the outer edge of the ball of the rail in the same manner as type A. Type C bond is designed for attachment to the underside of the rail, although there is a wide range of application where it can be used, as on third-rail installation, elevated roads and bridge structures. Type D bond is designed for use with the Weber patent rail-joint, or other makes of patent rail-joints in which the angle-plate extends under the foot of the rail and in which the outer plate extends so far beyond the head of the rail that type A or type C bond can not be used.

For cross-connecting and other special bonding the company has developed a terminal for use in connection with copper wire or cable, the cable or wire being soldered in a pocket provided for it in the terminal. The terminal is fitted with a solder-pocket which holds enough solder for its proper attachment to the rail. By the use of this terminal it is possible to add odd lengths of copper wire or cable, making a cheap and effective cross-bond.

One Application of the Roebling Soldered Rail-Bond.

Important Movement in Advertising.

The creation of a general advertising department for the New York Central lines and the placing in charge of that department the veteran railroad advertiser, George H. Daniels, who has been for nearly twenty years the general passenger agent of the New York Central Railroad, marks an era in the history of advertising in America.

The New York Central lines are the first great system to create an advertising department which covers all the railways in their system, and the far-reaching consequences of such a movement can not be appreciated at first sight, but this action on the part of the management of these lines emphasizes the value of advertising generally, and forces the conclusion of a strong belief in the efficacy of railroad advertising in particular.

Some idea of the importance of this new department can be had when it is understood that it will control the general advertising in America and in foreign countries of the New York Central, Boston & Albany, Lake Shore & Michigan Southern, Michigan Central, Cleveland, Cincinnati, Chicago & St. Louis, Rutland, and Lake Erie and Western railways and their leased lines, having their western terminals at Chicago, St. Louis and Cincinnati and their eastern terminals at New York, Boston and Montreal, and embracing more than 12,000 miles of the best equipped railways in the world.

Mr. Daniels has for many years been a firm believer in newspaper and magazine advertising, and therefore the organization of the general advertising department of the New York Central lines is of importance to every legitimate publication in America—daily, weekly or monthly.

In an address before the New York

State Press Association a few years ago, Mr. Daniels made the point that the railroad is the advance agent of commerce and that railway advertising had been of immense value to American manufacturers in calling the attention of the whole world to the excellent work done by our inventors and mechanics, as illustrated in the Empire State Express, the Twentieth Century Limited and other great trains that connect the East with the West; the average foreigner arguing that the men who are able to turn out such machines must be able to build almost anything, and that the farm machinery and all kinds of industrial machinery made in America must be of the very best quality. Railroad advertising has certainly been the means of bringing thousands of men here from foreign countries to investigate our manufactures and has wonderfully increased our foreign commerce.

Every legitimate newspaper and magazine publication in America will have a direct interest in the general advertising department of the New York Central lines, and every advertising agent on the continent will take a new lease of life because of this endorsement of the value of advertising.

The Bell Automatic Motors.

The accompanying illustrations show two types of the Bell automatic motor, manufactured by the Bell Electric Motor Company, 435-437 West Broadway, New York city. Fig. 1 illustrates a type of back-geared motor, which is excellently adapted for driving machine tools under all ordinary conditions. These motors are semi-enclosed, and are of very substantial construction, which suits them admirably to the operation of lathes and other similar machine tools.

Fig. 2 shows the Bell automatic motor, which is well adapted to all conditions suitable for this type of motor. The motor or generator is of the semi-enclosed, protected type, for direct current.

In addition to the two motors shown herewith, the Bell company manufactures a number of other types of both single, two and three-phase alternating-current and direct-current motors. The motors may be obtained in styles suiting them to the driving of exhaust fans, with worm and gear for very slow speeds, and in the enclosed and semi-enclosed types.

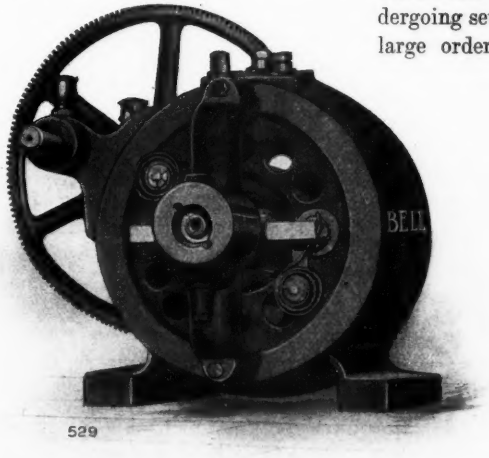


Fig. 1.—Back-Geared Motor.

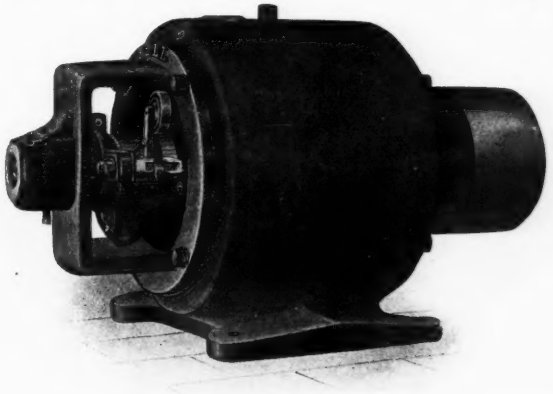


Fig. 2.—Automatic Motor.

A New Time Switch.

A new type of time switch, designed especially for central station work, has been put on the market by the Hartford Time Switch Company, of 97 Warren street, New York city. This design is the result of a number of enquiries for a switch to be used inside of iron electric light poles used in street lighting—and in this manner to do away with the annoyance and expense of having the lights turned on and off by hand.

The switch consists of an eight-day Seth Thomas clock in connection with a rotary switch, the whole enclosed in a dust and waterproof japanned cast-iron case, and is small enough to be put inside a pole of six and one-half inches diameter.

The Hartford Time Switch Company states that these switches have been undergoing severe tests in actual service, that large orders have been received on the basis of these tests, and that in putting them on the market now it is with the actual knowledge that the switch will substantiate these claims for it, *viz.*, with only weekly winding to turn the current on and off at such hours desired, to be an accurate timekeeper and that its simplicity of construction is such that the usual cleaning, which any clock movement requires every year or two, can be done by any local clock repairer.

In addition to the switch described above the company also manufactures a complete line of automatic time switches suitable to any requirement where regularity is desired.

New Type Time Switch.

For electric sign work it has a switch that automatically omits the Sunday operation, lighting only on the six workdays.

The Hartford Time Switch Company has long recognized that the vital point in a time switch is the clock movement, and for this reason uses nothing but the high grade Seth Thomas eight-day movement.

The range of work that this time switch covers is much greater than is generally realized. Special switches can be made to

fill almost any requirement, however unusual. As an illustration the company calls attention to a switch which throws on a signal light for ten seconds once a day, and one that turns off the lights in a store window two hours later Saturday night than on other nights.

Westinghouse Equipment for the Sarnia Tunnel.

Arrangements have recently been made between the St. Clair Tunnel Company and the Westinghouse Electric and Manufacturing Company for a complete electrical installation to operate freight and passenger trains through the tunnel which connects the American and Canadian divisions of the Grand Trunk Railway system of Montreal, Canada.

The plans and specifications were prepared by Mr. Bion J. Arnold, of Chicago, whose pioneer work in single-phase alternating-current traction is known to all engineers. The work of installation will be conducted under Mr. Arnold's supervision.

The equipment includes a complete power station containing boilers, stokers, coal and ash-handling machinery, feed pumps, feed-water heaters, condensers, water supply, fire protection and heating systems, piping, electric crane, steam turbine generating units, engine-driven exciting unit, motor-driven exciting unit, switchboard, feeder and distributing system, bridge and pole lines for catenary trolley construction, overhead work, bonding, transformers for power and light, light and power distributing systems, lightning protective apparatus, arc and incandescent lamps, round house motors, motor-driven pumps, drainage and sewer systems for buildings and yards, and electric locomotives.

Interest centres largely in the locomotives equipped with the series-wound single-phase motors developed by the Westinghouse company, which is the key to the entire system. There are to be six similar units designed to meet the requirements of the tunnel service of the Grand Trunk Railway. Each will exert a drawbar pull of 25,000 pounds on a two-per-cent grade at a speed of ten miles per hour. The locomotives may be operated from either end, and two or more may be coupled together and controlled in multiple from a single unit, so that there is practically no limit to the size of train which may be taken through the tunnel by the electrical equipment—other than that imposed by the limited mechanical strength of the coupling from car to car.

These locomotives are of the rigid frame type, with driving axle boxes and draft gear mounted on the same frame. Each unit will have three pairs of sixty-two-inch driving wheels, with a motor on each axle connected with a gear reduction of 18 to 95. It will weigh approximately sixty-two tons, all of which is on the driving wheels. Equalizer beams, similar to those used in standard steam locomotive practice, will distribute the weight among the six drivers. The frames will be made of cast steel and will be placed outside the wheels. The locomotives will be equipped with the Westinghouse friction draft gear.

The power equipment of each unit comprises three 250-horse-power, single-phase, series-wound motors of the same general type as those recently adopted by the New York, New Haven & Hartford Railroad for its terminal operations in New York. Pneumatically operated trolleys of the pantagraph type will collect the current from the overhead trolley line outside the tunnel,

The Sarnia tunnel of the St. Clair Tunnel Company passes under the St. Clair river and connects the divisions of the Grand Trunk Railway system which terminates at Port Huron, Mich., and Sarnia, Ont. The tunnel proper is 6,032 feet long. A single track leads through the tunnel, but the approaches are double track up to a point about 300 feet from each portal. From terminal to terminal, a distance of 19,348 feet, will be electrically equipped.

At the present time passenger and freight trains arriving from either direction are hauled through the tunnel by steam locomotives. Almost all of the freight trains must on arrival be divided, as they are too heavy for a single locomotive. The result has been that traffic is congested at the terminals and the entire service of the system impaired. It is expected that the electric locomotives will greatly relieve this congestion, as their greater capacity and flexibility will eliminate or largely reduce the necessity of dividing trains.

Alternating current at 3,000 volts, twenty-five cycles, will be delivered to the locomotives. Outside the tunnel the current will be fed through a No. 0000 grooved trolley wire and pantagraph trolley to the locomotive equipment. The trolley wire will be hung by a catenary suspension from steel towers which span the track or from bracket arms mounted on lattice-work poles of steel.

Tunnel operations are conspicuous fields for the electrical propulsion of heavy trains and the application of the single-phase alternating-current system to the St. Clair problem provides a most effective solution of the difficulties encountered.

The Chicago Electrical Show.

The management of the Chicago electrical show, which will be held in the Coliseum from January 15 to January 27, announces that final arrangements are being made to create a remarkable exhibit and to set forth a very complete representation of electrical development.

Announcement is made of the awarding of the first prize to Edward W. Wilson for the electrical show poster. The second prize was won by August Abelmann, this design to be used in the larger poster on the billboards. Fred Stearns won the third prize with a design which will be used on the catalogue cover.

During the two weeks of the show there are to be several special days. The two-hundredth anniversary of the birth of Benjamin Franklin will be observed on Wednesday, January 17, and bronze medallions are to be distributed as souvenirs of the occasion. The Northwestern Electrical Association will meet at the Great Northern Hotel, January 17 and 18, attending the exhibition in a body the second night of the convention. Other days will be set aside for special features, such as telephone day, and technical school and college day. Weil's Band, of St. Louis, will give afternoon and evening concerts during the show.

American Institute of Electrical Engineers' Building Fund.

The General Electric Company in view of the great importance and utility of the United Engineering Building as a home and centre for the engineering professions and arts has made a contribution of $25,000 to the land and building fund of the American Institute of Electrical Engineers. Mr. C. A. Coffin, president of the General Electric Company, who takes a warm personal interest in the matter, has also sent his own check for $5,000. The committee, which had already received gifts and pledges amounting to nearly $70,000, is greatly encouraged by this generous support of its work. The fund is now, with other new subscriptions, well over $100,000, and with renewed energy the committee has begun its canvass of the field with the object of securing the second necessary $100,000. About 600 members have already subscribed to the fund and the committee expects to have no difficulty in at least doubling this number. It has recently issued to the whole membership a handsome pamphlet, illustrating and describing the new building in course of erection in New York city, and detailing the steps that have been taken by the associated engineering bodies to give effect to Mr. Carnegie's original gift.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

UNITED STATES SIGNAL CORPS DEVELOPS A UNIVERSAL WIRELESS TELEGRAPH DETECTOR—Brigadier-General A. W. Greely, chief signal officer of the United States army, has announced that the United States signal corps has perfected inventions of wireless telegraph receivers which will enable the army to intercept and read the messages of every system of wireless telegraphy now in use.

MUNICIPAL ELECTRIC LIGHTING IN PHILADELPHIA—It is announced that Mayor Weaver is looking into the matter of securing a municipal electric lighting plant for the city of Philadelphia, Pa. The project has been under advisement for some time and the mayor has been collecting data with a view to submitting to the advisory board the feasibility of installing a municipal electric lighting plant.

LONDON UNDERGROUND ELECTIONS—Mr. Edgar Speyer has been chosen chairman of the London Underground Electric Railway Company to succeed Charles T. Yerkes. Sir George Gibb, general manager of the Northeastern Railway, was elected managing director and deputy chairman and also chairman and managing director of the Metropolitan District Railway Company, vacated by the death of Mr. Yerkes. Mr. R. W. Perks will continue as deputy chairman of the company.

MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY AUTHORIZES ISSUE OF $20,000,000 IN BONDS—The stockholders of the Milwaukee Electric Railway and Light Company have authorized the issue of $20,000,000 of four and one-half per cent refunding and extension bonds. The bonds will refund about $8,000,000 of various bonds of the company at present outstanding, and will leave available $12,000,000 of the issue for other purposes of the company. Part of this $12,000,000 will be used to fund the floating debt and the rest will be used from time to time for the improvement and extension of the lines.

EXTENSIVE MERGER AT COLUMBUS, OHIO—Developments in the reorganization and refinancing of the Columbus Gas Light and Heating Company, the holding company of the Columbus Gas Company, and the Central Ohio Natural Gas Company, are regarded as the initial step in the planning of a corporation controlling the lighting, heating and street railway lines of Columbus and other cities throughout the state of Ohio. It is thought that W. K. Schoepf, president of the Cincinnati Traction Company, will be at the head of the new combination. The capitalization will be $10,500,000. All of this stock will not be issued, however, a large portion of it being retained as treasury stock for future improvements and developments.

PENNSYLVANIA COMPANY TO OPERATE HIGH-SPEED ROAD BETWEEN NEW YORK CITY AND NEWARK, N. J.—It is understood that the Pennsylvania Railroad will own and manage a high-speed electric road between New York city and Newark, details having been perfected and agreements signed which will permit the road to run through the Hudson & Manhattan Railroad tunnels under the North river to Jersey City and thence to Newark, where a terminal is to be built. The line will connect with the subway road and the surface lines in New York city, with the Pennsylvania's lines to Long Island and the New England Railroad systems, as well as with the rest of the Pennsylvania system. Through trains will be run to Newark from several points in New York city, and connections will be made so that by a transfer system any point in New York may be reached by residents of Newark and its suburbs.

NIAGARA FALLS TRANSMISSION COMPANY TO INCREASE CAPITAL STOCK—The state gas commission has received the application of the Niagara Falls Electrical Transmission Company for permission to increase its capital stock from $100,000 to $5,000,000, and to purchase certain obligations of the Albion Power Company and the capital stock and obligations of the Niagara Falls Gas and Electric Light Company and to pay off retiring bonds of the applicant to the amount of $59,790. The Niagara Falls Electrical Transmission Company was organized for selling and distributing, in the counties of Niagara, Erie, Orleans, Monroe and Genesee, electrical current developed by the Electrical Development Company, of Ontario, Limited. It is proposed to construct transmission lines sufficient in capacity for at least 50,000 electrical horse-power. The capital stock is to be classified as $2,500,000 preferred and $2,500,000 common stock.

NEW 150-MILE SINGLE-PHASE RAILWAY SYSTEM TO BE OPENED SOON—The Toledo & Chicago Interurban Railway Company is about ready to begin operations in northeastern Indiana. At the present time about fifty miles of the road, constituting the Fort Wayne division, are completed. This division extends from Fort Wayne north to Garrett, a distance of eighteen miles, branching northeastward through Auburn and Waterloo to Butler, a distance of twenty miles, and then northwest to Avilla and Kendallville, about twelve miles. The line, when completed, will extend for a distance of about 150 miles from Goshen, Ind., on the west, where connection is made with the lines of the Indiana Electric Railway Company to Alvordton, Ohio, on the east, where connection is made with the Toledo & Western Railway. The southern branch, just completed, connects at Fort Wayne with the Fort Wayne & Southwestern Traction Company, running to Indianapolis; and the Fort Wayne, Van Wert & Lima Traction Company, which runs well into Ohio.

TO CONTROL PUBLIC UTILITIES IN NEW YORK CITY—A bill has been introduced in the state legislature at Albany, N. Y., to authorize Mayor McClellan to appoint five residents as a board of control, each to receive a salary of $7,500 a year. The board would have control of public utilities in New York city, including street, elevated and subway railroads, ferries, electrical subways, gas, electric light or power, steam, water supply, telephone and telegraph corporations. One of the members of the board shall be a civil engineer, one experienced in local railroad operation, one a wage-earner with mechanical experience, one a lawyer, and one a business man, each of whom shall have had ten years' experience in his respective line of occupation. The board is not to encroach upon the powers of the state lighting commission, but shall enforce that commission's orders. The board is to have investigating powers and is to look into all complaints promptly and its orders are to be obeyed by the corporations. The board is to act as arbiter between public utility corporations and their employés. Corporations may appeal from the orders of the board to the Appellate Division of the Supreme Court.

TO TEST THE FRANCHISE VALUE OF THE NEW TELEPHONE COMPANY IN NEW YORK CITY—The Great Eastern Telephone Company, which is allied with the Consolidated Telephone Company, of Buffalo, N. Y., is seeking to establish a telephone system in the city of New York. The Great Eastern Telephone Company has acquired a franchise granted to the New York Electric Lines Company in 1885 by the board of aldermen. Before the company could take advantage of the grant the legislature passed an act providing that all electric wires must be put underground and that the privilege of opening the streets must be obtained from the commissioner of public works. The commissioner refused to allow the company to open the streets and in the litigation which followed the company was defeated. Since it has been understood that the Great Eastern Telephone Company was planning to enter the city on the strength of this franchise a petition was lodged by Abraham Sartorius with Attorney-General Mayer asking him to begin an action on behalf of the people of the city for the annulment of the franchise on the ground that it had become void for non-user for twenty years. The attorney-general, it is announced, will hold a public hearing on the matter on January 13.

ELECTRIC RAILWAYS.

CORSICANA, TEX.—The Corsicana city council has granted a franchise over the streets of the city for the proposed interurban line to Palestine.

FREDERICK, MD.—The Washington, Frederick & Gettysburg Electric Railway Company contemplates the construction of an electric railway from Frederick to Thurmont *via* Yellow Springs and Lewistown.

HARDY, ARK.—A committee has been appointed to confer with similar bodies at Ash Flat and Franklin for the purpose of incorporating and financing the proposed electric car line between Ash Flat and Hardy.

WABASH, IND.—The Indiana National Traction Company's line between Wabash and Marion, eighteen miles, with trackage rights over the Wabash valley line, has been turned over to the Indiana Union Trackage Company.

ROCKFORD, ILL.—There is a possibility that the company now engaged in the construction of the Elgin-Belvidere electric line will build a branch to Harvard to connect with the Harvard-Lake Geneva line, probably from Marengo.

PUTNAM, CT.—Worcester, Mass., and Norwich will soon be connected by trolley. The line will branch off from Occum and go to Jewett City, and from there follow the grade of the Norwich & Worcester Railroad to Plainfield. Several bridges will have to be built.

WABASH, IND.—The Indiana Union Traction Company has begun the operation of the Indiana Northern traction line between Wabash and Anderson. The service will be hourly and the time between Anderson and Wabash, fifty-four miles, will be two and a half hours. Through service to Indianapolis will be established a little later.

MIDDLETOWN, CT.—Deeds have been filed transferring the tracks and holdings of the Middletown, Waterbury & Meridan Railroad to the New York, New Haven & Hartford Railroad Company. The tracks of the Middletown company pass through Middletown, Cromwell, Meriden, Cheshire, Prospect and Waterbury. The price paid was $100,000.

COLUMBIA, S. C.—The Columbia Electric Street Railway and Power Company announces that a steam plant will be constructed at once on the company's land. This steam plant will generate 4,000 horse-power and, while this is not as much as the company's normal development, will be sufficient to operate the system. The plant will be ready for use by August 1, 1906.

WHEELING, W. VA.—The Wheeling Traction Company has acquired a controlling interest in the Panhandle Traction Company, running from the upper end of Wheeling to Wellsburg with connections to Steubenville and other northern points. Consolidation of the two properties will follow as soon as preliminaries can be arranged. The capital stock of the Panhandle is $500,000 and the bonded indebtedness $420,000 at five per cent.

GENEVA, N. Y.—The engineers who will lay out the route of the proposed Geneva & Newark trolley line have begun work. The work will be pushed as fast as possible north to Phelps. The organization of the company was completed recently when the board of directors elected the following officers: Edward H. Palmer, president; Walter A. Clarke, vice-president; Thomas H. Chew, treasurer; Lansing G. Hoskins, secretary; Stanley W. Hayes, general manager.

WASHINGTON, PA.—Councils of McDonald and Canonsburg have been asked for franchises for the Bridgeville & McDonald Street Railway Company, backed by Washington and Allegheny county capital, for the construction of a trolley line between the points named. It is the intention to build a spur into Canonsburg from Bishop. By connection at Canonsburg with the Washington & Canonsburg Railway Company's interurban system Washington would be given connection with Pittsburg *via* Canonsburg, Bishop and Bridgeville, and the Chartiers valley would be opened to traffic.

ELECTRIC LIGHTING.

ALMA, KAN.—An electric light plant has been placed in operation at Alma.

CLEVELAND, OHIO—Cleveland is now furnishing current to light the town of Glenville.

CLEVELAND, OHIO—The matter of enlarging the municipal electric plant at South Brooklyn is under consideration.

FORT CROOK, NEB.—Fort Crook is now lighted electrically by current transmitted from the Omaha electric light plant.

BRUNSWICK, MD.—Electric current from the Shenandoah river plant of the Harper's Ferry Light and Power Company has been turned on in Brunswick.

LAPORTE, IND.—The Laporte city council has entered into a ten-year contract with the Laporte Electric Company for all-night street lighting service at $73 a light a year.

EAU CLAIRE, WIS.—The property of the Ladysmith Light and Power Company, including the real estate, equipment, poles, wires and franchise, has been sold to G. E. Newman for $3,100.

SANTA ROSA, CAL.—The city council has under consideration the installation of an electric light plant in connection with the proposed further development of the municipal water system.

TOLEDO, OHIO—Mayor Finch, of Toledo, Ohio, has signed the nine-cent electric lighting ordinance, and it is now a law. It provides that no company shall sell electricity for commercial lighting at more than nine cents a kilowatt-hour.

JOPLIN, MO.—Two new power dams are being planned by the Spring River Power Company, which are to be built on Spring river, one two miles south of the Kansas state line in Indian Territory and the other near Wyandotte.

SOUTH BETHLEHEM, PA.—Announcement is made of a new incandescent and alternating arc lighting schedule of rates which will go into effect February 1. By that time the Electric Light and Power Company expects to have installed in Allentown such of its new power-plant equipment as will enable it to properly supply electric lighting in the Bethlehems.

GLOBE, ARIZ.—N. L. Amster, of Boston, and J. N. Porter, president of the First National Bank, of Globe, Ariz., have purchased a controlling interest in the Globe Electric Light Company. This company will add a gas plant to its works, for fuel purposes, and will be reincorporated as the Globe Electric Light and Gas Company. It will have $200,000 capital.

DENVER, COL.—The earnings of the Denver Gas and Electric Company are showing large gains. For the month of November the company earned net $61,747. There were interest payments of $30,122 to be met, which left the surplus for the stock $31,625, or almost ten per cent. For the year ending November 30 the net earnings were $600,209, with interest payments of $361,675, leaving a surplus of $238,533, or six and one-half per cent for the year.

REDONDO, CAL.—The Redondo Electric Company, one of H. E Huntington's organizations, has recently been formed for the purpose of manufacturing and controlling the electricity used by the Los Angeles & Redondo Railway, as well as the Huntington lines in the city of Los Angeles. The company has made arrangements to erect a large plant near the ocean front, and will equip it with the latest machinery. The plant will be the largest of its kind in Southern California, and is to be completed and in running order within seven months.

ATLANTA, GA.—Mayor James G. Woodward has approved the ordinance granting a franchise to the Southern Light and Power Company and it has become a law. The ordinance gives the company a franchise for thirty years and provides for the collection of a gross receipt tax, two per cent, for twenty years and three per cent for the remaining ten years. It also provides that the company shall not charge more than $65 for arc lights nor $28 for incandescents. It fixes ten cents per kilowatt-hour as a maximum charge for current for lighting and six cents per kilowatt-hour as a maximum charge for current for power, with a discount of ten per cent where bills are paid before the tenth of the month.

PERSONAL MENTION.

MR. CLARENCE F. SCHULTZ has assumed the duties of manager of the Harrisburg (Pa.) exchange of the Pennsylvania Telephone Company, succeeding Paul H. Chadwick.

MR. JOHN R. KEARNS has been appointed manager of the Portland (Me.) office of the Western Union Telegraph Company. Mr. Kearns takes the place of Mr. K. J. Ruggles, who goes to Boston, Mass.

MR. M. J. OGDEN, chief engineer of the Central Massachusetts Electric Company for the past five years, has resigned. Mr. Ogden will go to Fairmont, W. Va., where he will associate himself with the Fairmont & Clarksburg Traction Company.

MR. JAMES G. ROSSMAN, of Atlanta, Ga., has been retained as consulting engineer by the Southern Light and Power Company, which is seeking a franchise from the city government of Atlanta to sell electric light and power to the municipality.

MR. FRANK B. KNIGHT, of Dallas, Tex., special agent of the Southwestern Telegraph and Telephone Company, was a New York visitor the first of this week. Mr. Knight came North on the sad errand of burying his wife, whose death was announced last week, at her old home at Kingston, N. Y.

MR. KENDALL BANNING, who resigned the managing editorship of *System* to enter the service of Bruce & Johnston, has become a partner in the company. Mr. R. H. Johnston, formerly partner of John M. Bruce, retired from the company last August to devote his entire time to special advertising.

MR. H. G. MADDEN announces that he has severed his connection with W. R. Brixey as agent, and has associated himself with the Sunswick Company, of Astoria, New York city, as vice-president and general manager. The company will carry on a business dealing in insulated wires and materials.

MR. H. H. NICHOLSON has been promoted to the position of division superintendent of the Utica division of the Central New York Telephone Company. Mr. Nicholson will be succeeded as district manager by C. W. Hitchcock, the present manager of the Rome exchange. Mr. Nicholson's division will include the districts of Cooperstown, Watertown and Utica.

OBITUARY NOTICE.

DR. OTTO A. MOSES, a well-known chemist, electrical engineer and inventor, died at No. 72 West thirty-fifth street, New York city, Wednesday, January 3. Dr. Moses was a son of Aaron J. Moses, of Charleston, S. C., where he was born in 1846. He was graduated from the University of Leipsic. On his return to the United States he became state geologist of South Carolina. Coming to New York about thirty years ago he entered business as a mechanical engineer and electrical expert. He was associated in early life with Thomas A. Edison, and in 1880 he represented Mr. Edison in Paris at the electrical exposition. Later he was connected with the Westinghouse Electric and Manufacturing Company. He was the founder of the Hebrew Technical Institute in Stuyvesant street, New York city, and was also associated with the Montefiore Home and the Hebrew Benevolent Orphan Asylum. He is survived by two sons and a daughter.

AUTOMOBILE NOTE.

AUTOMOBILE CLUB OF AMERICA—The annual banquet of the Automobile Club of America will be held at the Waldorf-Astoria, New York city, on Saturday evening, January 20. The map committee has prepared for early distribution an automobile route map covering the states of Massachusetts, Rhode Island and Connecticut, east of the seventy-third parallel of longitude, and south of forty-two degrees forty-five minutes north latitude.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

PORTLAND, ME.—The Scott Electrical Equipment Company has been incorporated to deal in electrical machinery, with a capital of $500,000. The officers are: M. W. Baldwin, president; J. J. Hernan, treasurer, both of Portland.

RICHMOND, VA.—The J. W. Smith Electric Company has been incorporated to do a general electrical construction business. The capital is $10,000 and the officers are as follows: J. W. Smith, president; R. N. Scott, secretary and treasurer, of Norfolk.

ELECTRICAL SECURITIES.

The opening week of the new year brought, if anything, disappointment in its developments in the financial community. The very evident indication of unloading in many quarters, following the boom of the last three weeks, gave an insight into the true condition of affairs such as has not been witnessed for some time. That the general investor was cognizant of the professional tone of the market was assured by the large amount of commission business which was done in very active selling, this leading up to a sharp break on Thursday of last week. The extreme activity of the market just before the close of the year, it is thought, has discounted, to a considerable degree, the investment demand, which it was anticipated would naturally follow the end of the year profit taking and dividend securing. Importance is attached to the further expansion in the iron and steel trade, and to the fact that last year's report of failures is the lowest for some time. This is also remarkable in view of the very greatly expanded general trade.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 6.

New York:	*Closing.*
Brooklyn Rapid Transit	88½
Consolidated Gas	176½
General Electric	179
Interborough Rapid Transit	233½
Kings County Electric	200
Manhattan Elevated	161½
Metropolitan Street Railway	124⅜
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	188

The Kings County Electric Light and Power Company has decided to issue forthwith $3,200,000 new stock at par to stockholders of record January 15. Each stockholder will be entitled to subscribe for new stock to the extent of 64 per cent of his present holdings. The proceeds of the new issue will be used for extensions and improvements.

The annual stockholders' meeting of the Brooklyn Rapid Transit Company will be held at twelve o'clock noon on January 26 in Brooklyn, N. Y. Books closed January 12 and reopen the day succeeding the final adjournment of the meeting.

Boston:	*Closing.*
American Telephone and Telegraph	136½
Edison Electric Illuminating	242
Massachusetts Electric	60½
New England Telephone	131
Western Telephone and Telegraph preferred	90
Philadelphia:	*Closing.*
Electric Company of America	11⅞
Electric Storage Battery common	83
Electric Storage Battery preferred	83
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	32⅞
United Gas Improvement	94

Philadelphia Rapid Transit gross earnings for December increased about $142,000, the largest gain of any month in the year. The large earnings are understood to have been influenced by the opening of the subway to Fifteenth street and the unusually large holiday trade and traffic. For the six months ended December 31, 1905, the increase in gross earnings over the corresponding period of 1904 is about $550,000.

Chicago:	*Closing.*
Chicago Telephone	135
Chicago Edison Light	160
Metropolitan Elevated preferred	70
National Carbon common	78
National Carbon preferred	115
Union Traction common	12
Union Traction preferred	40

The Chicago Telephone Company gained 25,330 telephones in 1905. The total now in use is 143,223. The gain for December was 2,920.

The Metropolitan elevated daily passenger average for December was 137,799, an increase of 15,211; for the year 124,271, an increase of 10,483. The Metropolitan earnings at the end of the fiscal year, February 28, will show a surplus of about $825,000. A daily average of 135,000 passengers is predicted for the coming year.

The South Side elevated daily traffic average for December was 97,495, an increase of 8,707. For the year the average was 90,301, an increase of 7,054.

The Oak Park elevated daily traffic average for December, including transfers, was 52,044, increase 4,650. The increase for the year was about 7 per cent.

INDUSTRIAL ITEMS.

THE ALPHADUCT MANUFACTURING COMPANY, Jersey City, N. J., announces its removal to the new factory at 136 Cator avenue.

THE ECONOMICAL ELECTRIC LAMP COMPANY, New York city, announces its removal to 96 Warren street. The new telephone number is 1728 Cortlandt.

THE ELECTRO-DYNAMIC COMPANY, Bayonne, N. J., in circular No. 18 describes and illustrates the application of the "Inter-Pole" motor to the driving of machine tools.

CLAUSSEN, BURCH & PILLSBURY, Minneapolis, Minn., announce a partnership to carry on the business of consulting engineering. The company will also have offices in St. Paul, Minn.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has ready for distribution the January issue of "Graphite." This contains a number of interesting sketches concerning the use of graphite products.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., is mailing a calendar card for January, 1906, upon the back of which is some descriptive matter calling attention to several lines of apparatus which the company is carrying.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., in bulletin No. 62 describes and illustrates electric hoisting machinery. The illustrations show various machines of this character, supplemented by tables giving specifications, including shipping weights of the outfits.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, Philadelphia, Pa., will have an elaborate exhibit at the electrical show at Chicago, Ill., January 15 to January 27. The company's exhibit will be in charge of the Chicago representative, Mr. William P. Crockett.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has published a calendar for 1906 bearing an illustration showing a Jeffrey coal-cutting machine and a Jeffrey locomotive. The inscription states that "the Jeffrey cuts the world's coal and the Jeffrey locomotive hauls it."

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, is distributing a large calendar which is unique in several ways. On each pad there is an argument relative to the features of the "Sterling Special" lamp. Accompanying each month there is also a small calendar comprising the dates of the month preceding and the month following the current calendar month.

THE JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., is distributing a handsome catalogue descriptive and illustrative of the Roebling soldered rail bond. This bond is made of a flat strip of copper wound to the required dimensions and shaped in a press. The strip is tinned to prevent corrosion, and the method of manufacture produces a one-piece joint of great flexibility.

THE CONSOLIDATED ENGINE-STOP COMPANY, 100 Broadway, New York city, is mailing a neat folder calling attention to the "Monarch" engine-stop and speed limit system. This directs attention to the fact that the "Monarch" system is a blanket insurance and life preserver combined. The scheme is very attractive, and this form of advertising ought to be of considerable benefit to the company.

THE GENERAL STORAGE BATTERY COMPANY, New York city, at the Chicago Electrical Trades' Exposition, to be held January 15 to January 27, will show, in addition to a full line of "Bijur" high-duty plates and batteries, a working booster system handling violently fluctuating loads while maintaining a steady load on the generator. This is accomplished by a "Bijur" automatic regulator working on a new principle.

THE ILLINOIS TELEPHONE CONSTRUCTION COMPANY, Chicago, Ill., has prepared a handsome catalogue detailing various elements of progress on the Chicago tunnel system which is being built for the Illinois Tunnel Company. The catalogue includes maps of the streets and intersections, diagrams of the various interesting details and a large number of half-tone reproductions of typical views of the installation.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., and Chicago, Ill., is distributing bulletin No. 14, descriptive and illustrative of private branch telephone exchanges. This bulletin is very handsomely printed, and, in addition to the descriptive matter and illustrations pertaining to the details, there are included a number of views of complete switchboards and switchboard outfits.

H. M. McCANDLESS & COMPANY, INCORPORATED, 67-69 Park place, New York, has just issued an attractive little folder on types of the "Empire" miniature lamps. In this folder thirty-two different miniature lamps are illustrated and described, including the various types of sockets and receptacles for miniature lamps. This company now has in press a comprehensive catalogue devoted to miniature lamps which will be ready for distribution in the near future.

STANLEY & PATTERSON, INCORPORATED, New York city, is calling attention to the many novelties it manufactures in the way of flashlight specialties. The company is the manufacturer of the "Matchless" specialties of every description, including tubular flashlights, vest pocket flashlights, coat pocket flashlights, electric candles, electric candles with flower shades, night lights, clocks with electric night lights, gas range lighters, electric gas lighters, illuminated scarf pins, and flashlight batteries and flashlight lamp bulbs.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., is distributing a circular calling attention to the special features of safety in its National Electric Code standard cartridge fuse blocks. Under the heading of "Greater Protection" the company is emphasizing the advantages of Peru blocks. Another circular describes the exhibit of the company at the electrical show to be held in the Coliseum, Chicago, Ill., January 15 to 27. This exhibit will display the Peru products and will also be unique in the number of novel fixtures which will make this booth of great attractiveness.

THE ABNER DOBLE COMPANY, San Francisco, Cal., is mailing to some of its friends a photogravure of a figure of Victory riding on a Doble tangential water-wheel. This is commemorative of the exhibit of the Doble company at the St. Louis exposition. The figure typifying Victory is a photographic reproduction from a bronze by M. Debut, the original of which is in the private office of Mr. William A. Doble, president of the Abner Doble Company. The water-wheel upon which Victory is riding is a photograph reduced to the correct scale of the runner of the water-wheel exhibited at St. Louis.

THE PHOENIX GLASS COMPANY—"Quality" always has been—and very appropriately—allied with the glassware for all illuminating purposes, manufactured by the Phœnix Glass Company. The inner globes of this company are justly celebrated for their excellence—possessing qualities so essential and necessary. No better evidence of their practical and satisfactory result exists than the fact that one of the leading electric light companies, whose first order was for 12,000 inner globes, subsequently increased the order to 25,000—and eventually to 50,000 per year. The company's line of outer globes for all systems partake of the same high character and excellence. The very large lines of incandescent electric globes and shades manufactured by the Phœnix company present a truly marvelous variety of design in rich cut, etched, white acid and imitation of leaded and glass effects. Special effort is made to have them conform to and be in perfect harmony with the prevailing school of designs of lighting fixtures—the Phœnix Glass Company appreciating the important fact that the glassware must possess design in perfect harmony with the fixtures on which they are used. While having large lines of lighting glassware for the higher grade of artistic fixtures—approved patterns, possessing taste and attractiveness—this company also presents a very complete assortment for the cheaper and more moderate priced demands.